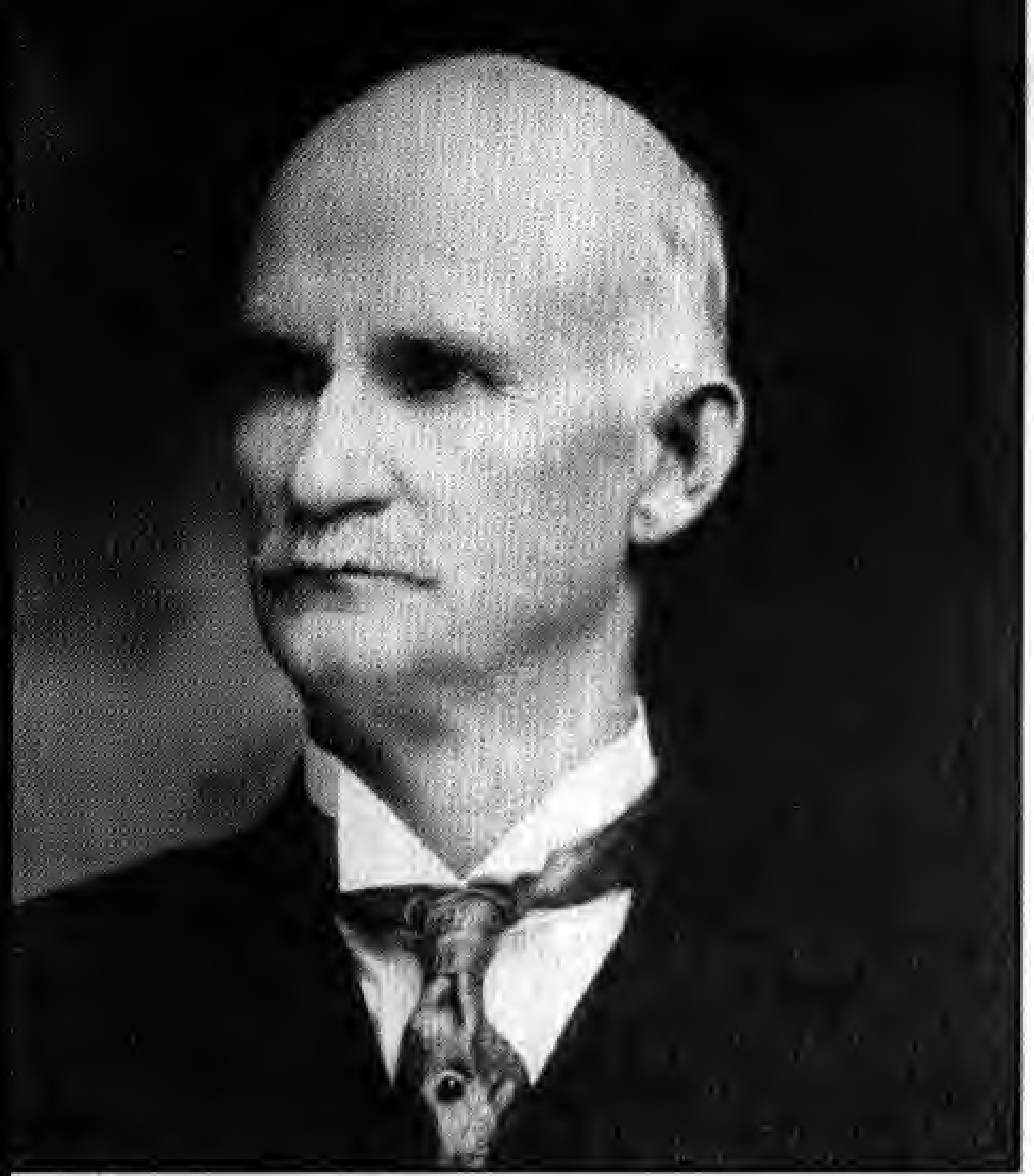
THE MACHINE GUN

VOLUME V

PARTS XII, XIII, XIV, XV, XVI, AND XVII

UNITED STATES OF AMERICA



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THE MACHINE GUN

VOLUME V

PARTS XII, XIII, XIV, XV, XVI, AND XVII

UNITED STATES OF AMERICA

THE MACHINE GUN

Development of Full Automatic Machine Gun Systems,
High Rate of Fire Power Driven Cannon, and
Automatic Grenade Launchers
by the United States and her Allies,
following World War II,
Korean Police Action, and the Vietnam Conflict.

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by

George M. Chinn

COLONEL, USMC (Retired)

Volume V of Five Volumes

1987

Personnel involved in automatic weapon development seldom agree on anything, but there is one facet in this field of endeavor that all are in complete accord. Namely, that the successful aircraft weapon represents the highest state of the art.

There is no known aircraft cannon or machine gun, either automatic or externally powered, that cannot be modified for ground or ship board use. However, there are many outstanding automatic firing mechanisms that are suitable for ground deployment that cannot be successfully altered, modified, or reengineered for aircraft armament.

Consequently, the purpose of this volume is to focus primarily on aircraft weaponry. Perhaps future studies will cover the evolution and progress of ground versions, but in an effort to preserve the flavor and clarity of Volume V all other types must, regretably, be omitted.

PREFACE

A series of publications entitled "The Machine Gun," sponsored by the Bureau of Ordnance, Department of the United States Navy, was prepared with the belief that the next best thing to actual knowledge, is knowing where to find it. The research summarized within the covers of these volumes was compiled in such a manner as to place in the hands of those rightfully interested in the art of automatic weapon design, the world's recorded progress in this field of endeavor.

Volume V begins with 1952 and continues to 1987. The primary purpose being to update the concepts, experiments, success, or failure of the state of the art in machine gun development. Volumes I, II, III, and IV of "The Machine Gun" series brought conventional weapons systems up to 1952, at which time further development was officially terminated.

This work consists of artists' conceptions, line drawings, photographs, progress reports, company brochures, along with proving ground tests, plus combat recommended changes, to correct malfunctions that inevitably occur.

All source material used to prepare and finalize the manuscript was excerpted from documents previously downgraded to unclassified (by authority of EPSO-CNC-B3 of 3249 July 1970), and all patents revealed are in public domain. Volume V is neither government funded nor sponsored. In this way, we were able to document chronologically the success or failure of each contract entered into by industry and the military in attempting to advance the state of the art in the evolution of the machine gun and aircraft cannon.

For purposes of clarity and uniformity, the topics within the chapters have been arranged in as nearly the same format as possible. Because the goal of this book is to present, without editoralizing, the case history of each gun in the form the cognizant activities chose. Deviations from their arrangement of material have been made only where the original reports were organized so differently that rearrangement for consistency of presentation seemed desirable.

So that this technical information can be presented in an orderly manner, it is further broken down into the basic principles that have governed the development of automatic weapons since the beginning of their conception.

Held to the strictest interpretation of the definition[1] and to the means by which the function is accomplished, there is only one primary force that actuates any automatic weapon: namely, the energy generated by the explosion of the powder charge contained in the chamber of the barrel. There have been, to date, only two known means that can be derived from this source of pow,er that have resulted in successful operation: (1) the rearward thrust of the recoiling mass: and (2) pressure generated in the bore by the expanding gas of the progressive burning charge. The former is known as recoil actuation, while the latter is labeled gas operation. All known means used in making an automatic weapon complete a full cycle fall into this broad classification, whether the mechanics employed be reciprocating or rotary.

The recoil-operated type of weapon can be further broken down into two distinct classifications: short and long recoil. Gas operation, however, seems to have no limit in its application. For instance, the residual pressure remaining in the bore a few milliseconds after the projectile has cleared has been, for lack of a better term, called blowback, while in reality it is but another form of gas operation.

However, the most common method of employing the energy created by the gas of the exploding propellant is to tap the barrel and let the expanding gas be brought to bear on an actuating device such as a piston, lever, etc. The system is universally referred to as "gas operation," erroneously implying that this is the only way gas pressure is utilized as a source of power.

If one were satisfied only with generalities, it would be quite in order to state that there are only five known practical applications for accomplishing sustained fire as outlined in the definition of an automatic gun: (1) short recoil; (2) long recoil; (3) gas pressure in the bore bled off externally through an orifice (gas operation); (4) residual pressure remaining in the bore a few milliseconds after the projectile has cleared (blowback); and (5) blast energy generated by the expanding gases after being released from the confines of the barrel at the muzzle end (muzzle blast actuation)[2]. These are considered the basic principles and from these simple variants of power, more than 3,000 patents have been issued since 16 June 1884 on operational features of machine guns.

So thoroughly have the gun designers of the past covered the subject that since World War I the individual was indeed skilled in his profession if he could even make an improvement on a feature that had already been in existence a long time, much less originate something that could rise to the dignity where it could truthfully be called an invention.

There is a tendency to use general terms too loosely in describing certain types of actions. For instance, the word "blowback" is invariable employed when describing any weapon that uses this form of actuation either wholly or in part. This unusual power supply has been exploited to such a degree that it takes at least four distinctly different classifications to cover the application of this method of utilizing residual pressure for completing a cycle of operation: (1) pure blowback (Bergmann); (2) retarded blowback (Schwarzlose); (3) delayed blowback (Scotti); and (4) advanced primer ignition (Becker). Each system is strictly adaptable to certain types of actions and is utterly impractical other than for a specific purpose. For example, the calibre .22 Colt Woodsman pistol uses pure blowback and is a well-balanced, highly efficient hand arm, and for this type of weapon such a method practically defies improvement. However, if this system were applied to a conventional 20mm cannon, the bolt alone would need to weigh in the neighborhood of 380 pounds, with an approximate rate of fire of 200 rounds a minute, both of which would be totally unacceptable. If advanced primer ignition were used, the weight of the 20mm weapon could be held to 90 pounds and the rate of fire would be about 600 rounds a minute, while if delayed blowback were employed, the overall weight of the gun would be slightly more (about 100 pounds), but the weight of the bolt or recoiling parts could be held to a bare minimum (6 pounds), and the rate of fire could be brought up to as much as 1,000 rounds a minute. On the other hand, the maximum elasticity of the conventional type cartridge case, coupled with the inevitable high chamber pressures of today, makes the timing factor too critical to permit any consideration of retarded blowback in the design of a large calibre automatic weapon. Such comparisons are limitless when based on the fundamental principles governing the design of automatic weapons.

If this work can help in any small way to revive in this country the almost forgotten art of automatic weapon design, a field so thoroughly dominated by Americans in the past, the effort and toil that have been spent in preparing the book will have been repaid.

---

[1] Automatic Machine Gun—A weapon capable of sustained fire with its operating energy being derived wholly from the force generated by the explosion of the propellant charge.

[2] Although relatively unimportant, two other systems should be mentioned to complete the picture. "Blowforward" is a method in which the barrel is held to the rear by heavy spring pressure against a solid non-recoiling breech that supports the cartridge, gas pressure driving the projectile forward through the bore to move the barrel off the empty cartridge case. "The Gast system" is a double-barrel arrangement whereby the firing of one barrel furnishes the power to load, lock, and feed the other barrel, with unlocking being tied in with the first part of recoil movement.

ACKNOWLEDGMENTS

The help and encouragement received from many sources in the preparation of this work can never be fully acknowledged. The following individuals are listed in at least partial recognition of such contributions.

Special recognition must go to Adm. Malcolm F. Schoeffel for initiating the program that resulted in THE MACHINE GUN series, Volumes I, II, III, IV, and V. It was only through his fore sight that the project came into being.

To Ms. Joyce Ward Watts, Editor and Research Evaluator; Ms. Donna Bodner Duncan, Typesetter and Lay-out Artist; and Ms. Rebecca Sadler McKinney, Research Analyst; who after volunteering to assume full responsibility for arranging an overwhelming collection of material from a meaningless mass of unorganized facts inherited from earlier attempts to produce Volume V, THE MACHINE GUN, goes the full credit for making this publication possible.

Expertise, combined with their determined head on facing of the challenge with such high professional skill, left all others involved in the project with a deep respect of their talents, and a few of us with a bit of envy.

That three dedicated local women could compile such a highly technical manuscript into readable continuity that here-to-fore defied the efforts of highly trained engineers, was beyond comprehension. Too much praise cannot be given for this accomplishment, for which the country in general, and those who must design and foster automatic weapons, should be forever grateful.

The untiring personal interest, guidance and professional advice of three service friends, Maj. Jack Elliott, USMC; M. Sgt. George McGarry, USMC; and Marvin Haines, USN; is deeply appreciated, and they are responsible for whatever measure of success Volume V of this series achieves. There is no way to evaluate the efforts of these three living legends of Navy and Marine Corp Aviation Weaponry.

The meticulous reading of the manuscript by Byron Crawford and his valuable suggestions, based on an extensive knowledge of automatic weapons, added greatly to the completeness of this work.

Commendation must be given to Tom Griswold, Spindle Top Research Project, for his patient and industrious acquisition of much of the original research material that forms the nucleus for this publication.

The mass of data, consisting of a compilation of technical manuals, operational pamphlets, design specifications, and test reports, was loaned from the files of Ms. Joan Elizabeth Brookes-Smith, former head of the Kentucky Microfilm Department.

The cutaway drawings and diagrams of complicated mechanisms, as well as other technical art work, were prepared by Tim White, Ramp Staff Artist, in a manner that reflects the highest of skill.

Norman Lawson, a Kentucky Legislative Research Commission Consultant, displayed an encyclopedic knowledge in the field of marking and official designations, which was invaluable to the overall project.

For excellent cooperation and service, special thanks are extended to the staff of the many libraries, museums and other activities that were consulted. Among them, the Naval Photographic Center, the Library of Congress, Army Library, Army War College Library, Sea Systems Command Library, Aberdeen Proving Grounds Library and Museum, and the U.S. Marine Corp Museum and Library, Quantico, Va.

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Last but not least I would like to acknowledge Gene Click, Charles Hardin, and Royce Isham, my local consultants, who were always on hand to volunteer their services.

George M Chinn

Colonel, USMC (Retired)

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Mandatory compliance posted in all offices controlled by the Bureau of Ordnance and the Bureau of Aeronautics to cover experimental and production development of aircraft weaponry. This working requirement met with overwhelming success through World War II and Korea.

"To plan and develop by years of experience, the needs of Naval Aviation and base its requirements under conditions of war, and never upon those of peace. The principal function of this organization is to harness authority and responsibility so that they can never be separated, so that a designer cannot design a gun, then throw credit or blame onto the producer, or later escape the final issue and responsibility therefor. One man is to be responsible for each bit of material or development from its start to completion, its issue, its service performance, and later its overhaul and repair. Given this responsibility, he is to be clothed with the requisite authority over all its details."

PART XII

POWER DRIVEN CANNONS AND MACHINE GUNS

Chapter 1

GATLING PRINCIPLE VULCAN GUN

GENERAL ELECTRIC

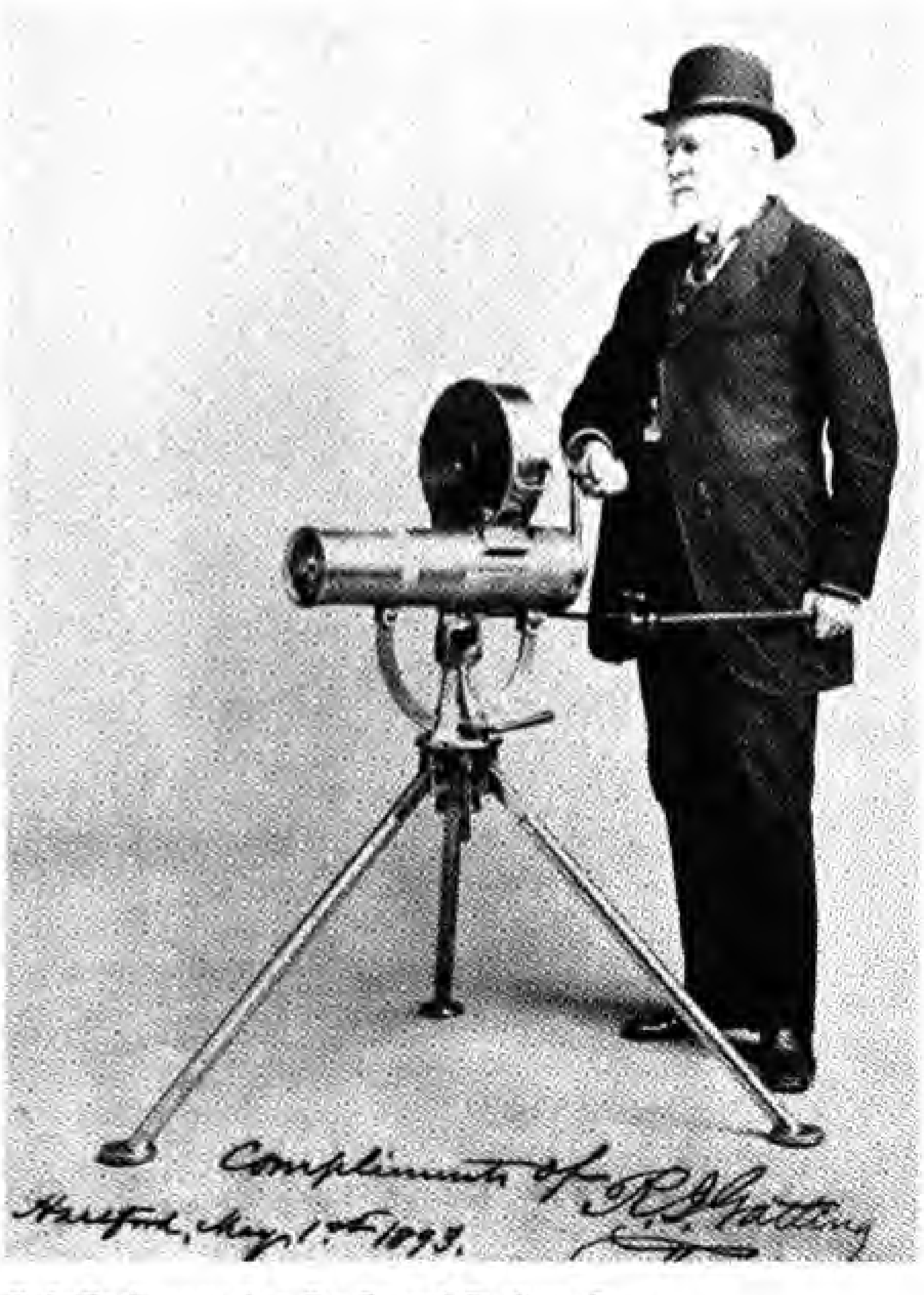
Vulcan's Stream of Fire

Introduction

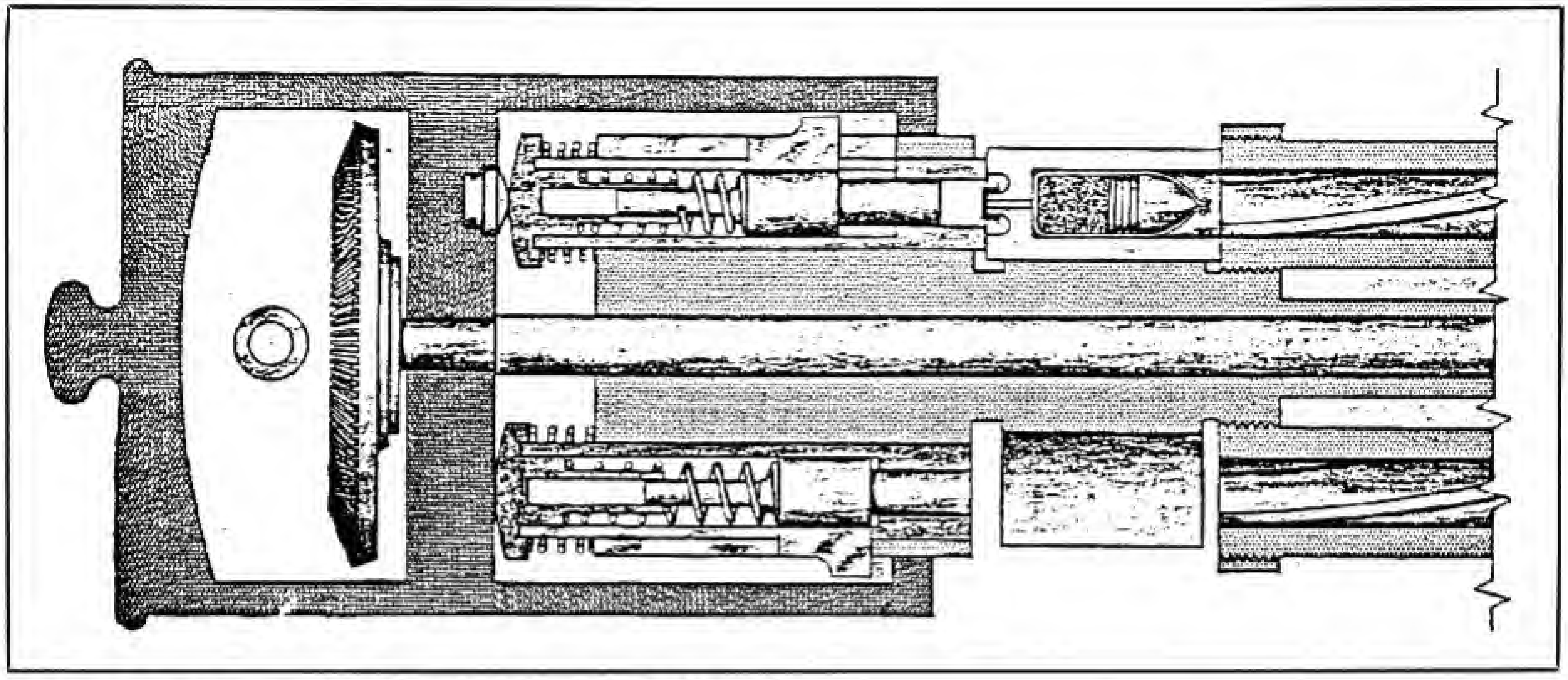
Vulcan was the ancient Roman "God of Fire." Vulcan today is the rightly chosen name given to the accepted and proven machine gun, the M61A1, by General Electric, that fires the most intense and sustained stream of projectiles ever produced by a single gun mechanism. It fires over 100 projectiles in one second.

The Vulcan is the re-invented and perfected step-son of the famous Gatling multi-barreled machine gun patented and first produced by Richard J. Gatling in 1862.

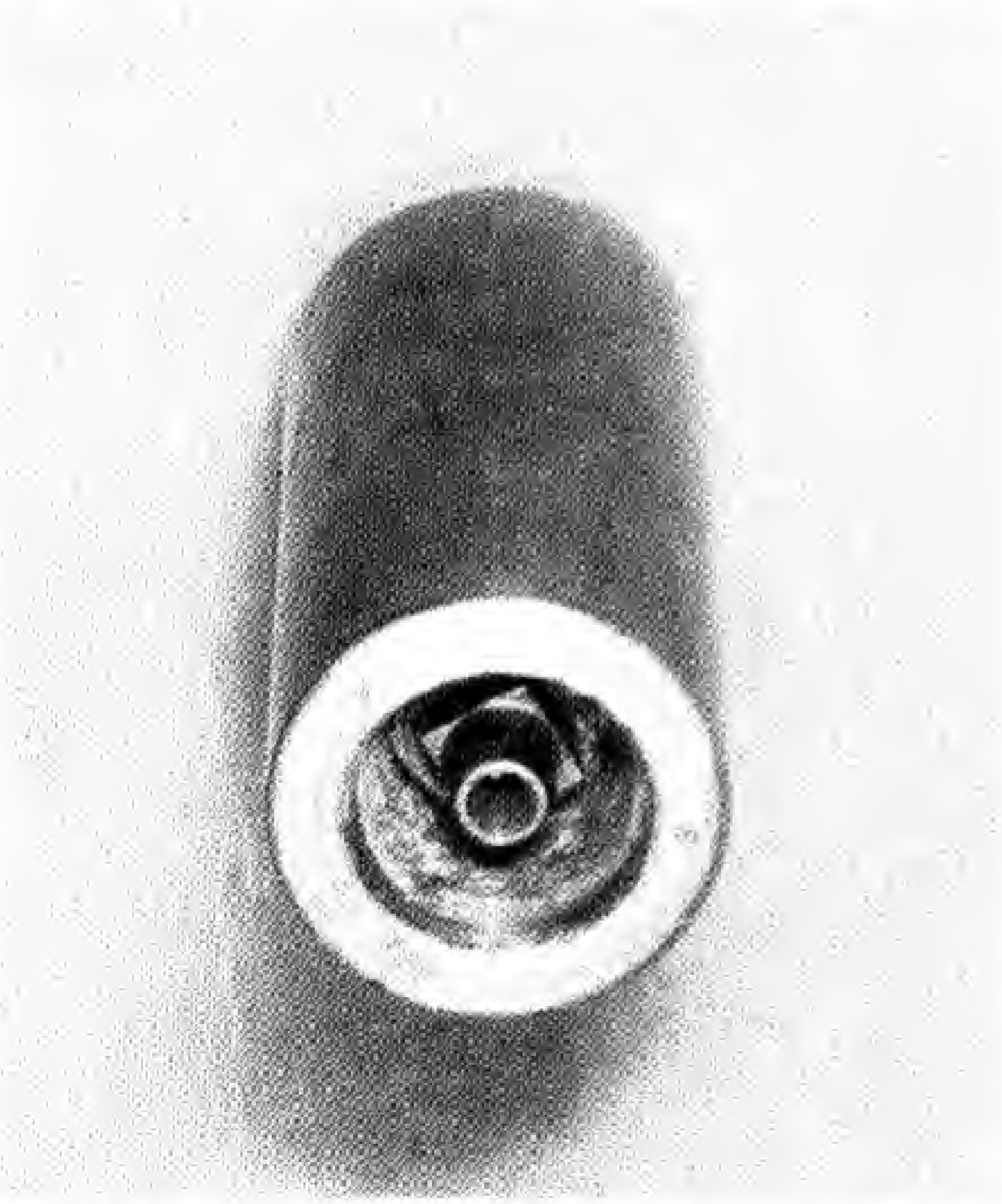
History has it that the North was deprived of a great ordnance officer when Major General Gorgas joined the Confederacy, but this loss was more than offset when Richard Jordan Gatling moved to the North in 1844, to manufacture and market several of his mechanical inventions.


Compliments of R J Gatling
Hartford, May 1st 1893.

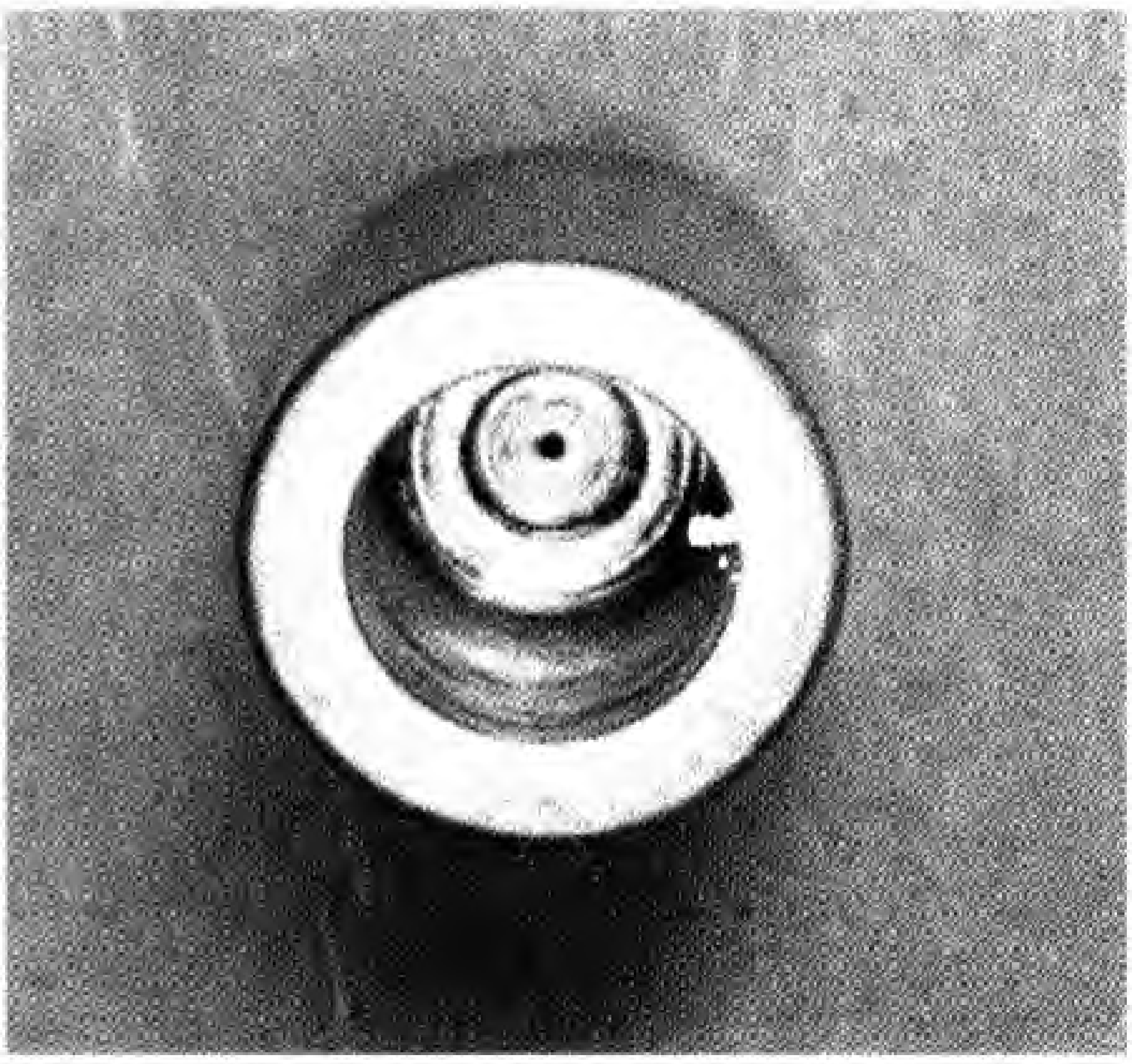
R. J. Gatling with a Six Barrel Gatling Gun



A Section View Showing the Action of Gatling's First Model Gun.



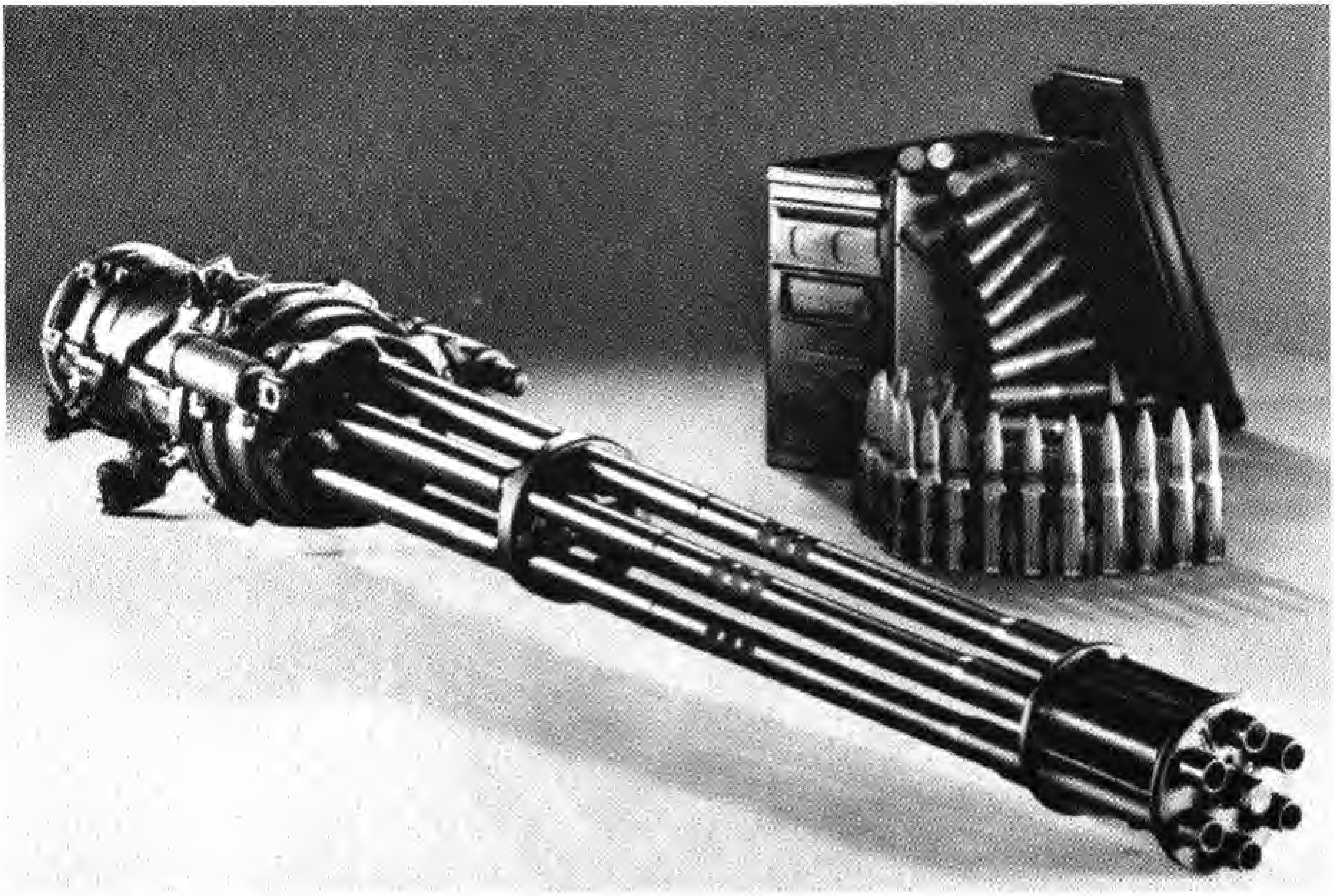
Steel Charger that acted as Firing Chamber in Richard Gatling's First Model Gun.



Steel Charger acting as Firing Chamber.

Gatling's first gun was crank-operated with six revolving barrels, having a bolt for each barrel. Cocking and firing were performed by cam action and the weapon was gear driven. By taking advantage of the machine tool progress, he was the first to have used successfully a method of camming to insure positive action and certainty of fire.

This model had many of the bad features of its forerunner, the Ager. It used paper cartridges and steel chargers that acted as firing chambers. The chargers were primed with percussion caps on nipples and the bolts acted as srikers to fire the caps. The chargers were supported during combustion by a cylindrical piece that housed the striker. A hopper gravity feed similar to that of the Ager was also used.



M61A1 20mm Vulcan Gun

Gatling was born in Hertford County, N.C. on 12 September 1818, descending from parents who were of English colonists in North Carolina. He conceived plans for guns that were needed in defense of installations, bridges, etc. and patented his first gun in 1862. These first guns were soon perfected and they became some of the most remarkable firing mechanisms of all history—the Gatling Gun.

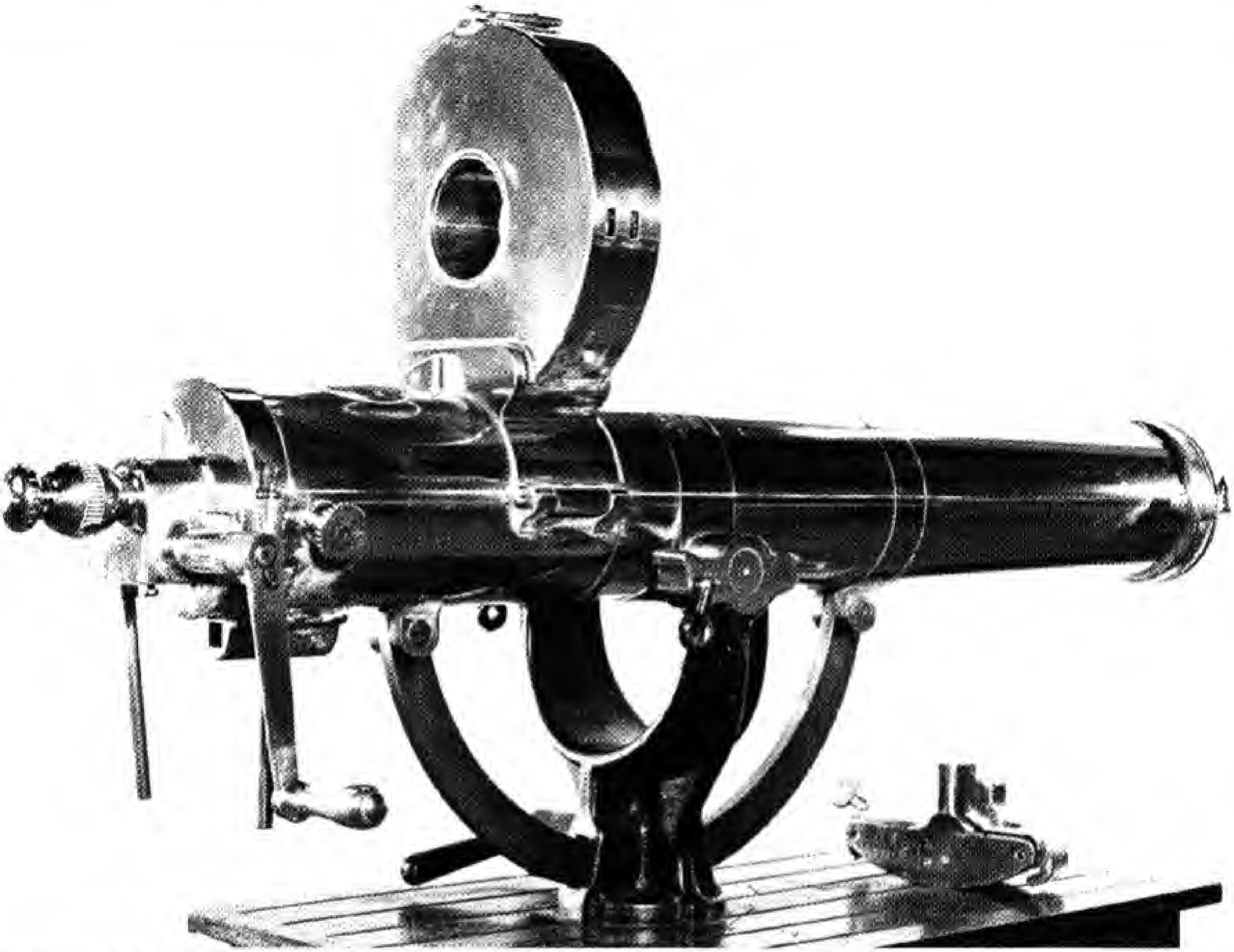
The gun operation was simple, requiring one man to install loaded feeders, while the operator took aim of the gun and turned it's crank. The crank revolved ten barrels. As the barrels turned, the cartridges were dropped into grooves in front of the gun bolts. A spiral cam pushed the bolts and cartridge forward until the cartridges were chambered in the barrels and fired one at a time.

Gatling lived to see his weapons progress from loose powder and percussion cap to primed metallic cased ammunition, from black to smokeless powder, and to see tests that replaced his hand crank with an electric motor.

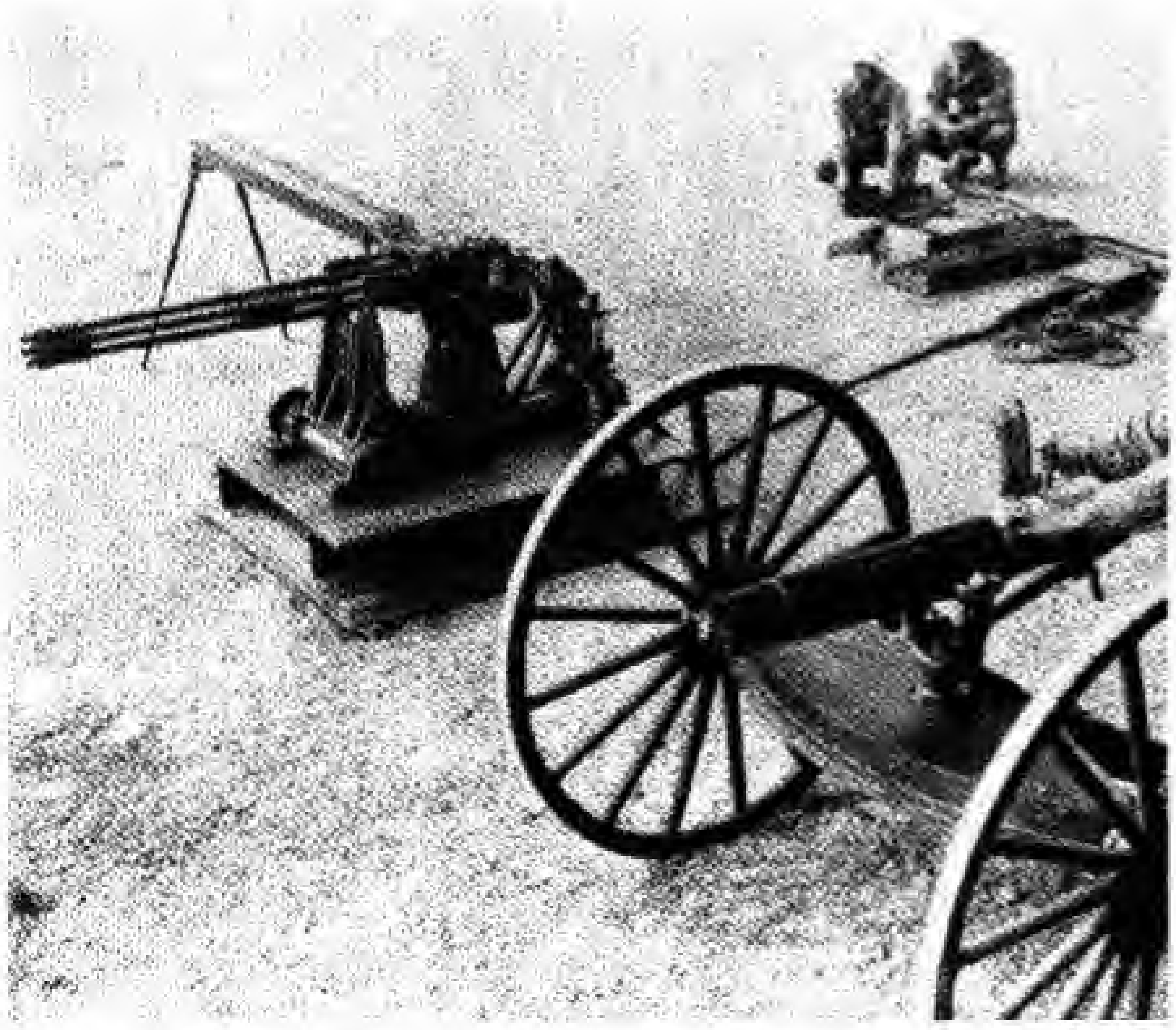
General Electric in 1946 recognized with the Ordnance Corp. the potential of Gatling's "before-its-time" invention, and applied a high tech electric motor, coupled with modern gun mechanism design and high strength materials, to fire the resulting Vulcan gun at more than 6000 shots per minute in sustained bursts.

A new family of Vulcan guns soon came about that fired many different cartridges, the 37mm, 30mm, 27mm, 25mm, 20mm, calibre .60, calibre .50, 10mm, 7.62mm and 5.56mm, all firing at gun rates from 200 shots per minute (spm) to 10,000 spm. These new guns are of various configuration in response to military requirements. Some have seven barrels, others have six or five, four or three.

It is due to the Vulcan's high performances that these guns have been chosen to arm almost all of the U.S. Air Forces fighter aircraft for the past three-and-one-half decades. The Vulcan and its variations have also been called to serve on bomber defense, on gun pods, on the famous "Puff the Magic Dragon"



An Original Gatling Machine Gun with an Accles Feed



The M61 and its Predecessor, the Gatling Gun

(side fire), on U.S. Navy ships for missile and aircraft defense, on most all helicopters for all the services, and on the U.S. Army's Vulcan Air Defense Systems.

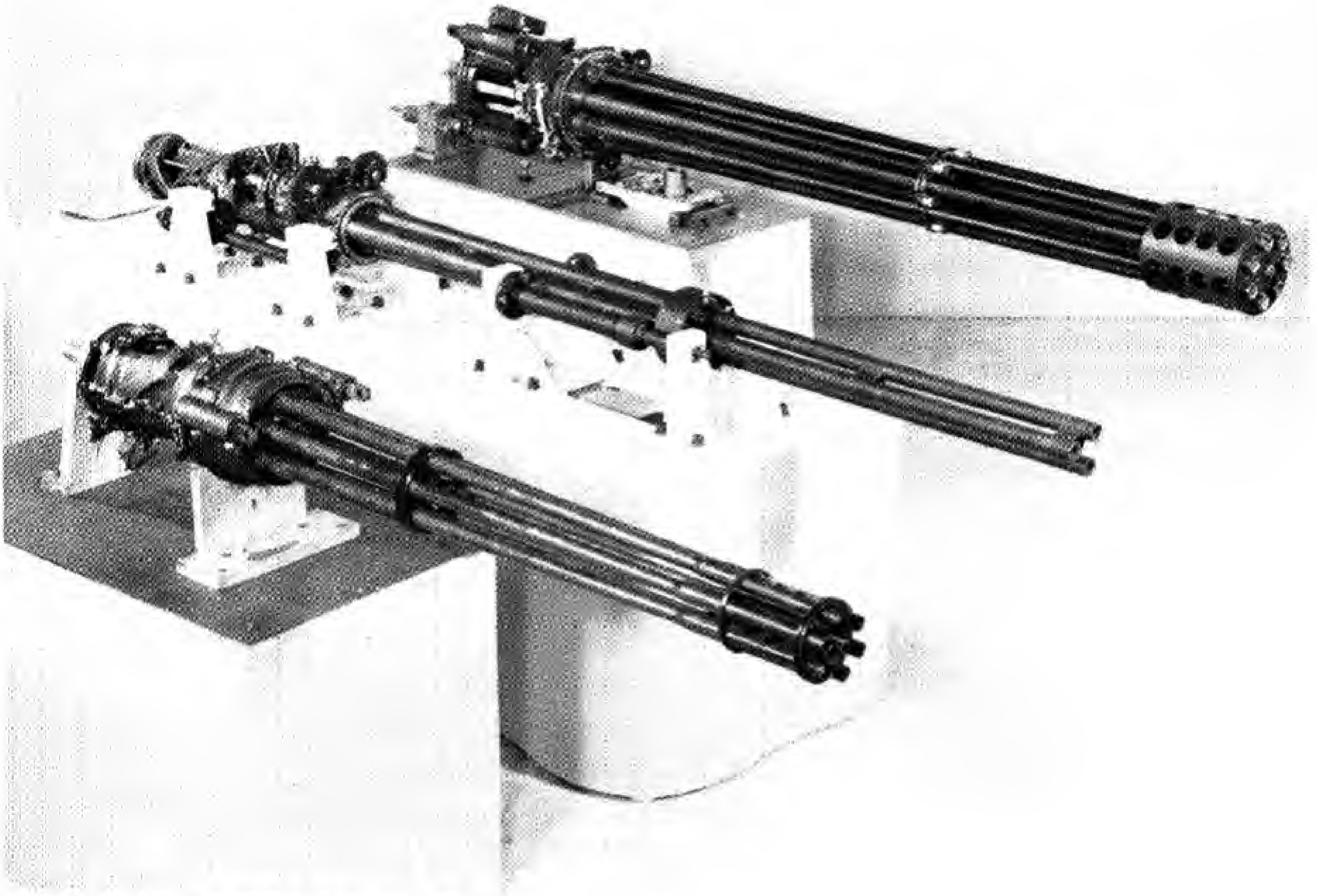
The Vulcan's firing sustainability, its field proven reliability and maintainability, and, its modern lightweight designs and materials have provided the U.S. Military and its allies with this family of guns and systems that have met every combat and environmental requirements and situation.

These various externally powered firing mechanisms and armament systems have been in production since 1957. Some are still in production in 1986, as is the M61A1. Other models were developed and tested for military reasons, but never attained production status.

These guns are listed in the following table showing some of their variations, ammunition used and applications:

Gatling Principle Guns

Gun	Ammo	No. of Barrels	SPM Firing Rates	Applications
Vulcan M61 and M61A1	20mm	6	6000	F104, F105, B52, B58, B66, F111, F4, F106, F14, F15, F16, F18 Phalanx, AMX, AC119, AC130, SUU-16/A, A7
Vulcan M168	20mm	6	1000 to 6000	VADS 1. M163 - Self Propelled 2. M167 - Towed
Vulcan GAU-4/A	20mm	6	6000	Gas Drive SUU-23/A Pod
Vulcan M195	20mm	3 (short)	1500	HUEY-CORBA AH1G M35 System
Vulcan M197	20mm	3 (light-weight)	750 to 3000	GPU-2/A Pod Turrets: 1. AH-1J 2. OV-10
Vulcan II T212	30mm ADEN-DEFA	6	6000	Development
XM118	30mm ADEN-DEFA	3	2000	Development
GAU-6	10mm	3	2000	Development
Minigun M134/GAU-28/A	7.62	6	up to 6000	Side fire, Helicopters AT-37, POD, VADS, Trucks, Boats
Minigun M133	7.62	6	6000	Gas Drive Pod (Development)
Microgun XM214	5.56	6	up to 10,000	1. Development 2. Six-Pak - Development
GAU-7/A	25mm	6	6000	Caseless Development
GE CAL 50	Cal. .50	6 and 3	8000	Development
Avenger GAU-8/A	30mm	7	2100 and 4500	1. A-10 A/C 2. Goalkeeper
Equalizer GAU-12/U	25mm	5	3800	1. AV-8 Harrier 2. Surface Vehicles (Development)
Avenger GAU-13	30mm	4	2400	1. GPU-5 Pod 2. Surface Vehicles (Development)
CHAG	30mm	3	1500	Light Wt. - A/C Development



M61A1, CHAG, and GAU-8/A Machine Guns

History of Vulcan

At the close of World War II, it was realized by the U.S. Military that the new high speed jet fighter aircraft had changed the requirements for airborne guns. In air-to-air combat the time on-target was reduced to well below three seconds.

This meant, to be effective and to score air-to-air kills, new guns were needed to supply more projectiles on target in a shorter time. More short bursts were needed also in a shorter time requiring greater reliability and sustainability. Decreased time of projectile flight to target demanded higher muzzle velocities.

However, most military aircraft at this time were equipped with little more than modified ground weapons that were certainly imcompatible with the advent of the jet age.

The Navy and the Ordnance Corp opened studies to attain new designs for more effective aerial guns. Contracts were signed with industry and universities to conduct conceptual gun design studies and to build and test fire development models of new high performance guns for air combat.

General Electric at that time was involved in providing armament systems to the Air Force for bomber defense using the M24A1 single barrel 20mm Machine Gun in dual mount turrets. General Electric also, as a result of this work, became aware of the need for more effective guns, and in 1946 was awarded a contract from the Springfield Armory based on General Electric'sproposal to modernize the Gatling Gun principle.

Richard J. Gatling's rotating, multiple barrel design, patented over three quarters of a century earlier in 1862, contained the promising features that could be modernized to obtain the new up-to-date needs of a very high firing rate with sustained, reliable fire power. In fact, in 1893 it was demonstrated in a very simple test that a Gatling Gun could be fired at up to 3000 spm using an electric motor and belt to drive the Gatling's crank.

This proved correct when in 1949 General Electric started testing the first model of its new Vulcan Guns. This gun was the T45 (Model A). It fired calibre .60 ammunition and fired at about 2500 shots per minute from its six barrels being driven by an electric motor.

Although this first gun was heavy and the firing rate was low, it provided technical data as a firing test bed for improved design and performance that was to follow.

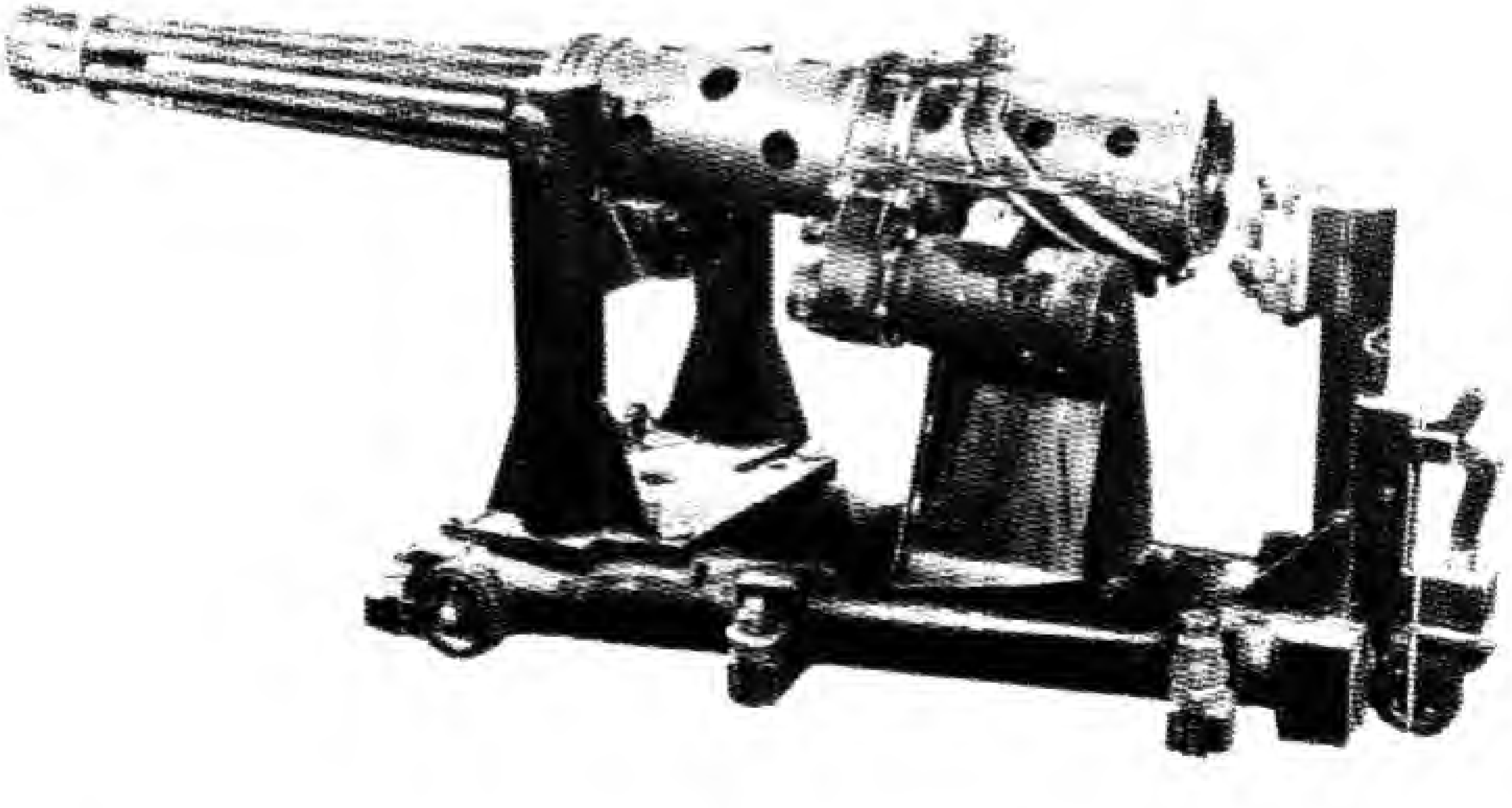
The T45 proved again that the Gatling principle of rotary motion eliminated gun bolt buffers which caused extremely high impact, accelerations, and was the gun design of the future. The T45 proved that the earlier planned requirement of 6000 spm firing rate with greater parts life and fewer malfunctions were correct and could be attained. There were test firings of 10 guns that included flight tests on an F-94 at Eglin Air Force Base and firings at the Springfield Armory, at Aberdeen Proving Grounds and at Wright Patterson Air Force Base.

The problems that were recognized and had to be refined included excessive weight, high drive power to accelerate the gun to full rate in 0.4 seconds, ammunition capability for firing electrical primers, weak ammunition belts, and links, larger storage containers, barrel cluster integrity and heating, gun clearing after each burst, gun feeding and case ejection and gun bolt lock stiffness.

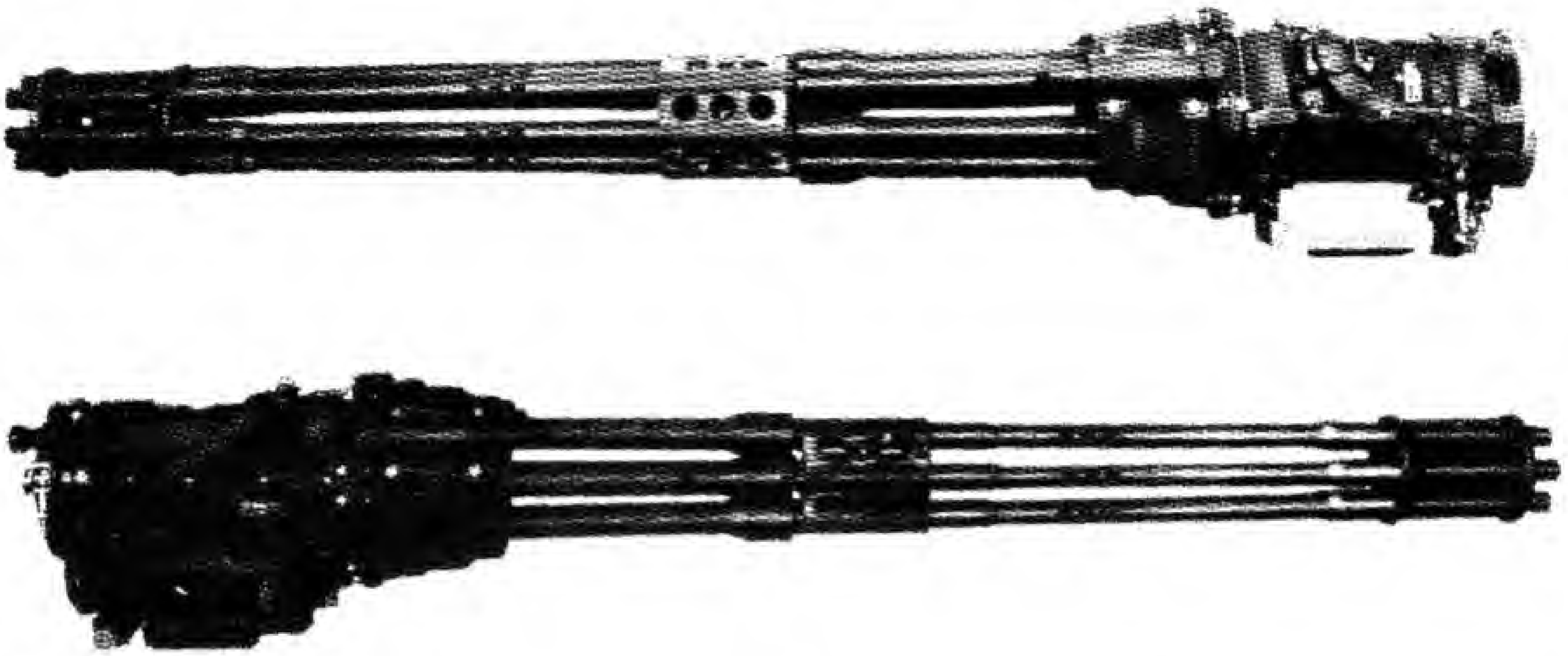
A new contract was signed with General Electric to work out these problems with a new design gun. The new gun was the T171E1 called the Model C. It had six barrels and fired 20mm ammunition at about 4000 spm. It weighed 365 pounds, down from 426 pounds of the T45.

From 1953 to 1955 there were thirty-three T171E1 guns produced and tested at GE and the government testing agencies. Over 700,000 test shots were fired, establishing a reliability of 9000 shots per malfunction, and a parts replacement schedule at 12,000 shots fired.

Design work also started on the next model, the T171E2 (Model D). Weight was reduced to 262



Model C Vulcan



Model D Vulcan

pounds, number of gun parts reduced from 576 (Model C) to 448; and, the firing rate was increased to 6000 spm. This gun, the T171E2 was considered the production design, and was the forerunner of the M61A1.

However, a major design problem developed in testing the T171E2 in December 1954. Case stretch was noticed in the fired cases. The problem was excessive breech deflections. Modification kits were designed and provided to the finished guns in test and test firing continued. These kits consisted of stiffer breech components, so that as of October 1955, the T171E2 guns had fired over 500,000 shots at up to 16 test agencies on 92 guns shipped from GE.

The design was changed to build in the stiffer breech components. The new model was called the T171E3, and the first guns were shipped in April 1956. Subsequently 200,000 rounds were fired as the new guns, which proved successful so that the T171E3 model was cleared of any serious case stretch problem.

By December 1956, the T171E3 gun development was considered complete. Production rates were increased, and manufacturing was moved to the GE plant at Burlington, Vermont. By August 1957 production rose to 50 guns per month. In December 1957, the gun was designated the M61; and over one million rounds of 20mm ammunition had been fired on Vulcan guns.

During this time, the Vulcan II program was in progress, designing, producing and testing the 30mm version of Vulcan called the T212 which was quite similar to the T171E1. It has the same multi-lug, twist lock on its gun bolt assembly which was different than the new drop lock on the T171E2, T171E3 and the M61.

Production was cut back in early 1959, at which time there had been 480 M61 weapons delivered.

However, production and improvements continued. The first large block change occurred in 1964, when the Vulcan was designated the M61A1, with a new low torque, high parts life, main gun bolt driving cam of cycloidal/constant force design. The M61A1 was designed to be used on the F105 Fighter where a gun torque problem developed with the M61 preventing the aircraft from achieving full 6000 spm firing rate.

New aircraft installations were being made; and new improved systems components were designed, such as, the Linkless Ammunition Feed System for the F105D Fighter, which provided complete ammo control in storage and in transit, plus for the first time, the capability of returning spent cases and dud rounds back to storage, rather than being ejected overboard from the aircraft.

Gun variations of three barrels and gas drive guns for use in helicopters and gun pods, etc. were developed, built and put into operation. The 7.62mm

F-105

Minigun was successfully designed in 1962 and first used on "Side Fire" in Southeast Asia.

By April 1974 there was a milestone of 10,000 Vulcan 20mm guns shipped. This rose to 15,000 guns by December 1981. There were 10,000 Miniguns built by early 1971.

The successful GAU-8/A 30mm Avenger was designed and built for the A-10 ground support aircraft during the 1970's.

The U.S. Marine's Harrier (AV-8/B) was outfitted with the 25mm GAU-12/U Equalizer. Pod shaped conformal carriages (two) were fastened to the aircraft. One contained the gun, the other held the ammo in a new linear ammo feed system.

A new version of the GAU-8/A 30mm gun was developed. It had four barrels, designated the GAU-13/A and was used in the GPU-5/A Gun Pod. The feed system designed was a cylindrical shape the same as the pod, spiral-double back linear feed, with a pneumatic drive.

Other guns such as the GE Calibre .50, the Microgun 5.56mm Six-Pac, the Caseless GAU-7 and the CHAG were designed, built and tested up into the 1980's.

Numerous ground vehicle installations continued to come off the drawing boards to go into tests for various military agencies, one of the most notable being the Goalkeeper which is a GAU-8/A 30mm gun installation for shoreline or shipboard anti-missile defense.

These gun designs and installation successes at General Electric having started in the late 1940's, after World War II, using the basic gun principles of Richard J. Gatling's famous gun and patent of 1862, are continuing to serve the U.S. Military at this time, having completed four decades and looking forward to new achievements into the fifth.

Surely Richard J. Gatling deserves the first and foremost acclamations for his insight of modern military weapon needs when he nurtured his famous invention with conceptual and persevering skills so that twentieth century man could take his gifts and build on them as has been done in the defense of our grateful country and of our friends throughout these last forty years.

Vulcan Operation

The Vulcan Gun, like its Gatling predecessor, has six barrels that form a circular cluster. The cluster rotates, being externally driven by an electric motor.

Only one barrel fires at a time. As a barrel is rotated to the sixth firing position on the housing, it is fired. It does not stop rotating and passes through a 60° sector of the housing while the breech is locked.

At the end of this sector, this barrel is about to be unlocked; and the following barrel in the cluster has been locked and is about to fire. This continues as long as the cluster is rotated; each barrel in turn is brought up to the firing position and fired.

All other gun functions like feed, ram, extract and eject are performed at their specific fixed location on the housing. Looking from the rear, the gun barrel cluster rotates counterclockwise, inside the fixed housing.

On the housing at these fixed positions finite functions are performed resulting in all functions having fixed housing locations. As any barrel in the cluster is rotated past a fixed housing location, a gun function is performed on it. Therefore, at any one time, all gun functions are happening to one of the six barrels.

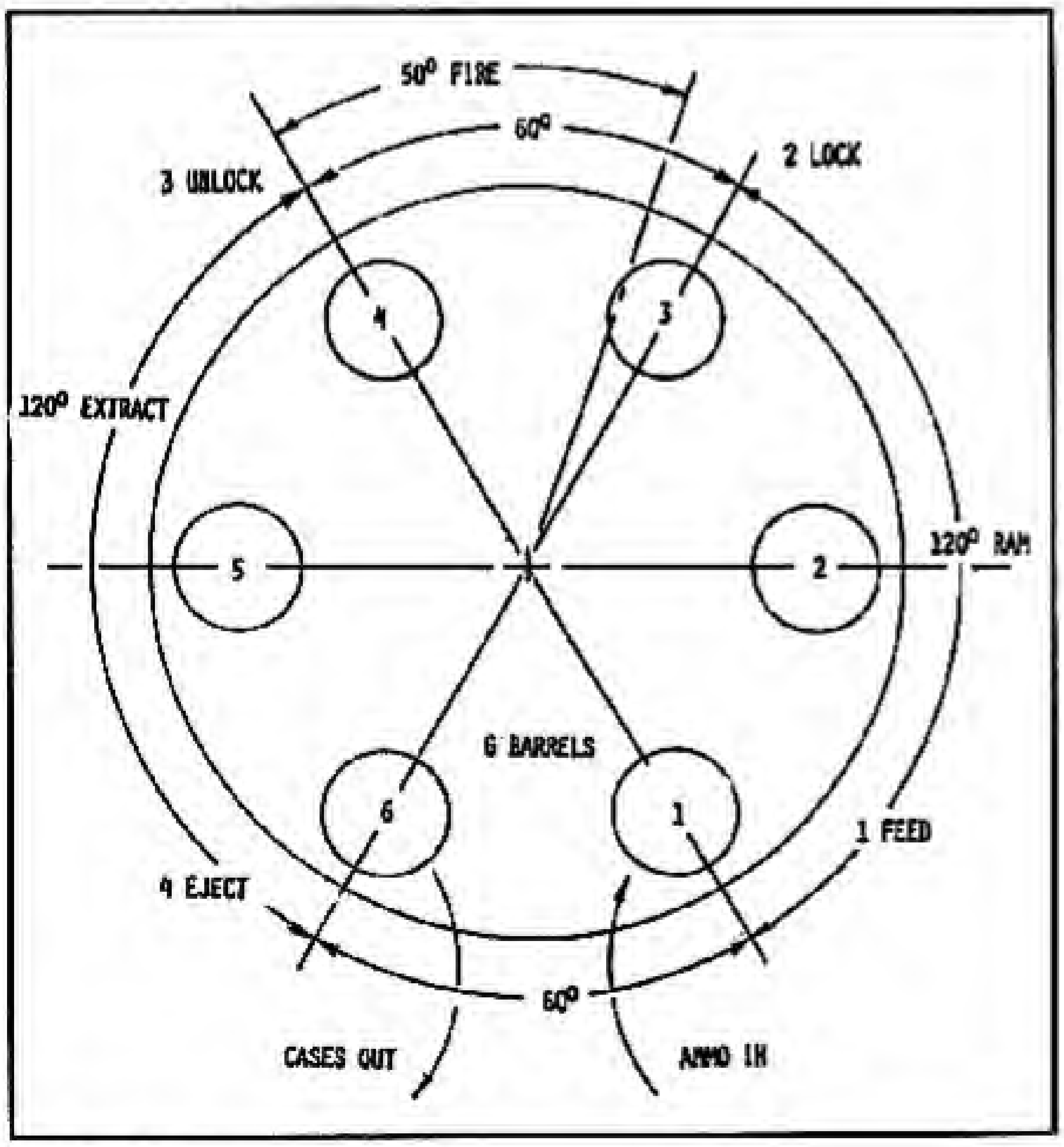
As the barrel cluster rotates to the next 60°, then each barrel experiences the next gun function ahead. So, as the rotation continues all barrels are driven through all functions in turn.

It is because of this multiplicity of barrels and events happening together that the high firing rate occurs.

The result is that the six barrels in a cluster that rotates 1000 revolutions per minute produces a firing rate of 6000 shots per minute or six shots per revolution.

The six barrels are located at 60° to each other. The gun functions also maintain a 60° relationship. Starting at point one feeding is accomplished. The cartridge is rammed into the breech and the breech locked and the firing pin extended at point two called firing in 120°. The breech is kept locked as the pressure builds; the projectile leaves the muzzle and the pressure reduces. This happens over 60° (10 milliseconds at 6000 spm) and the breech starts to unlock at point three. The spent cartridge case is then unlocked and extracted from the breech and started to eject from the gun, all in the next 120°, called point four. Rear dwell extends for the next 60° where point one and feeding reoccurs.

These gun functions require time and rotational displacement to complete them. Ejection, for example, happens over about 30° of rear dwell. At point four, the spent case starts on a tangential path, to be cammed out of the gun by the guide bar. Ejection is complete halfway through rear dwell and the case is free of the gun. At this time, a new cartridge starts to enter the gun from the feeder guides and sprockets.



Firing Cycle

The cartridge is fully in place at point one. It also took 30° to enter the gun along a somewhat tangential path. At 6000 spm these functions take about five milliseconds each to perform.

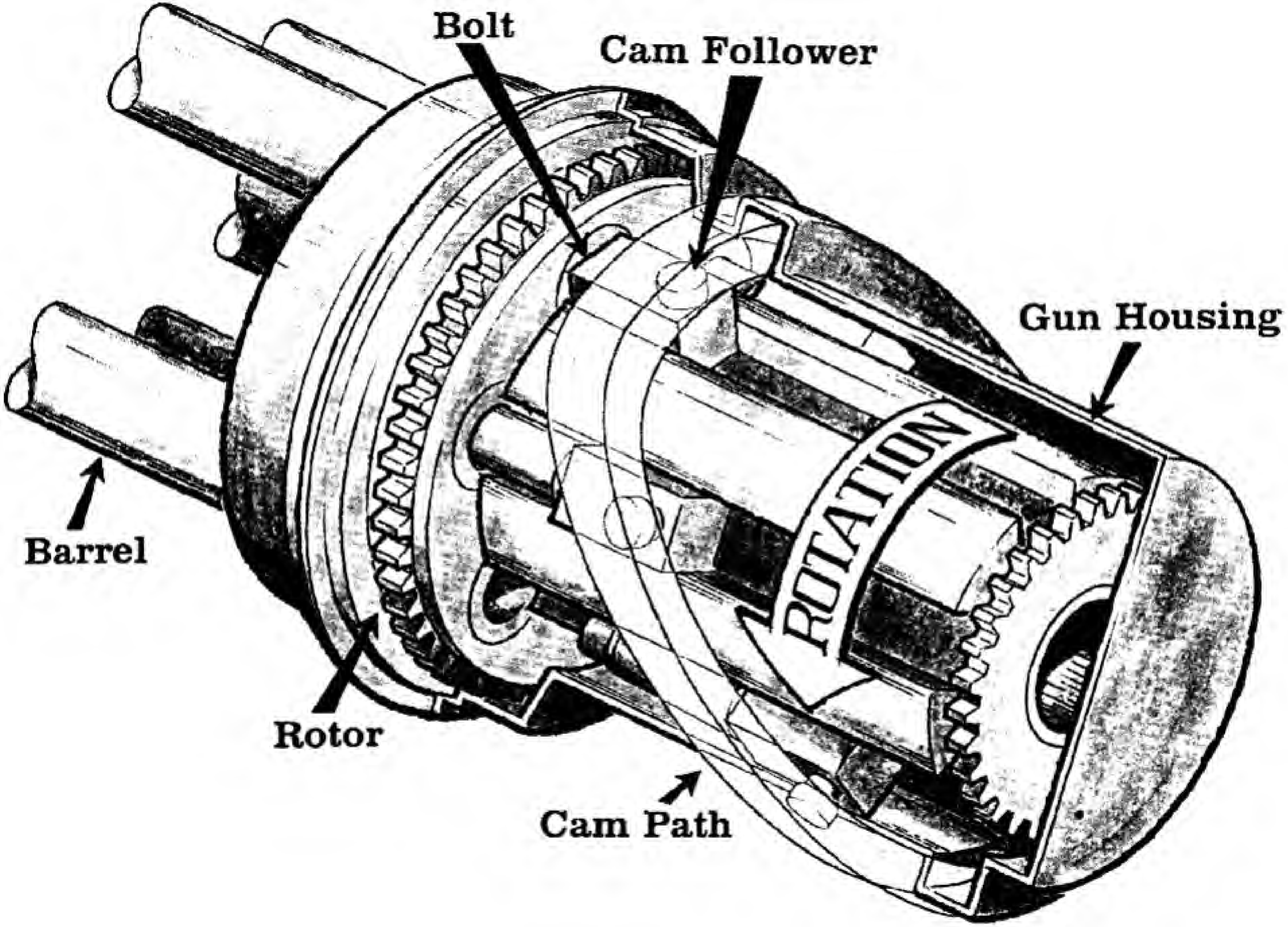
The same takes place at the breech end of the function diagram. Locking takes about 15° to execute. It starts 15° before point two and is completed at point two. The firing pin needs 3° to extend and the pin is protruding at point two. Breech gas build up and projectile exit from the muzzle takes three milliseconds (approx. 20° after point two). Gas pressure decline takes the rest of the 10 millisecond breech locked time. Unlocking starts at point three and takes 15° to complete before case extraction begins. Extraction then takes 105° and is completed at point four.

Likewise, ramming starts at point one and is complete at the point of starting to lock (15° before point two) for a total ramming displacement of 105°.

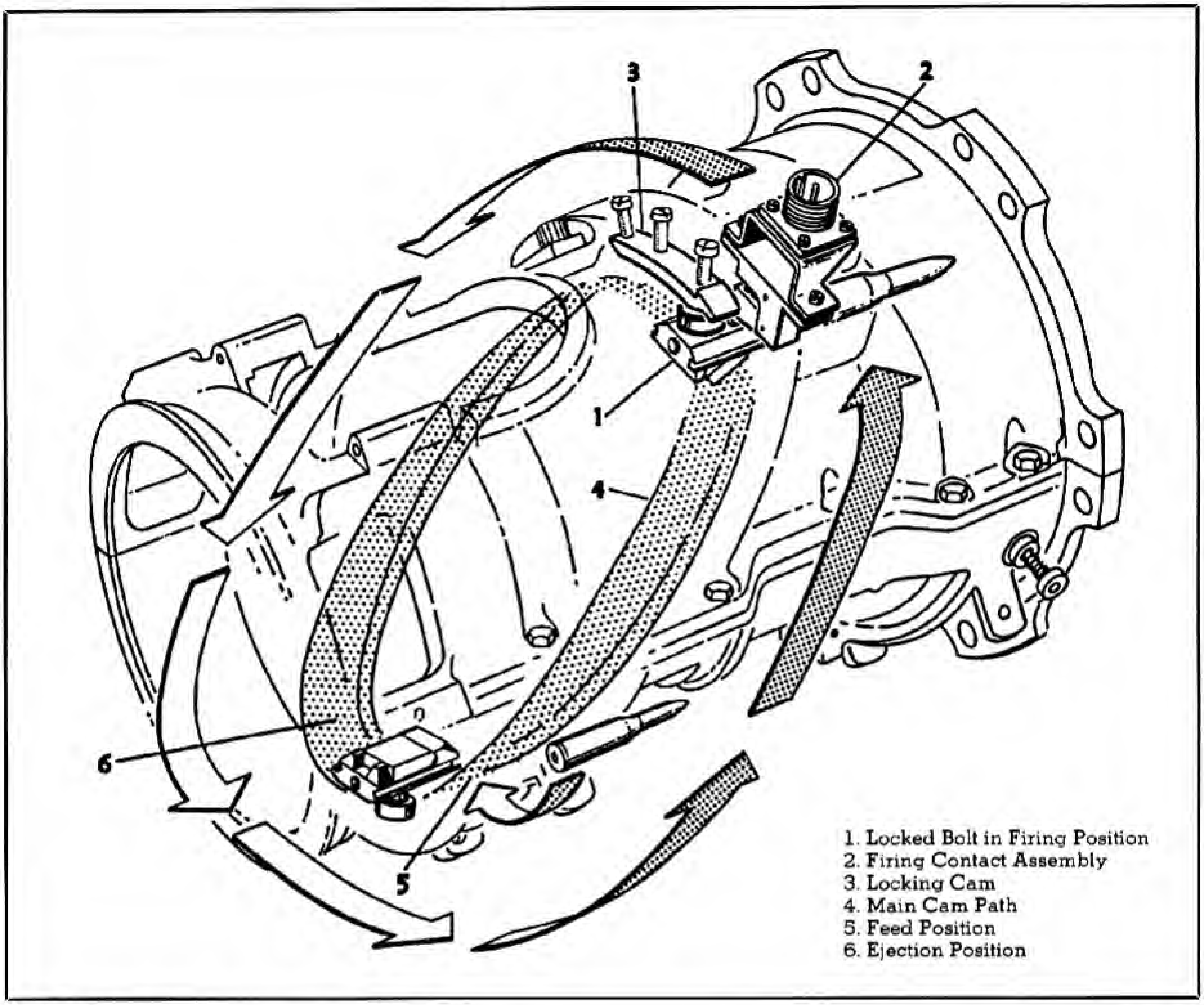
The Vulcan in its simplest form is a rotary gun. As viewed from the outside, its barrel cluster rotates at 1000 revolutions per minute for 6000 spm. There are other forms of motion inside the gun. The principle one is the longitudinal motion of the gun bolt assemblies. They ram new cartridges and extract spent cases just as in every other gun that has a single bolt and a single barrel.

The six gun bolts (one for each barrel) slide fore and aft on the trackways of the gun rotor which also secure the bolts to the rotor. The rotor rotates as the barrel cluster rotates. The gun bolts then also rotate with the rotor.

The device that makes the gun bolts slide back and forth is the main gun cam machined inside the fixed gun housing. A roller on top of the bolt rides in this cam. The cam is somewhat elliptical when viewed from the top of the gun. It is laid in the housing at about a 45° angle when viewed from the side of the gun. It has two dwell sections, one forward for firing, and the other to the rear for ejection and feed. The side sections (45° angles) are used for ramming and extracting. Smooth cycloidal shape curves connect the side sections to the dwell sections, making four corner cams. The first corner accelerates the bolt and new cartridge forward up to ramming speed. The second corner smoothly slows them just as final chambering without any debulletting. The third corner accelerates the bolt and spent case to the rear, beginning at initial extractions, up to full extraction speed. The fourth corner slows them to zero aft speed just before ejection.


Bolt
Cam Follower
Gun Housing
Barrel
ROTATION
Rotor
Cam Path

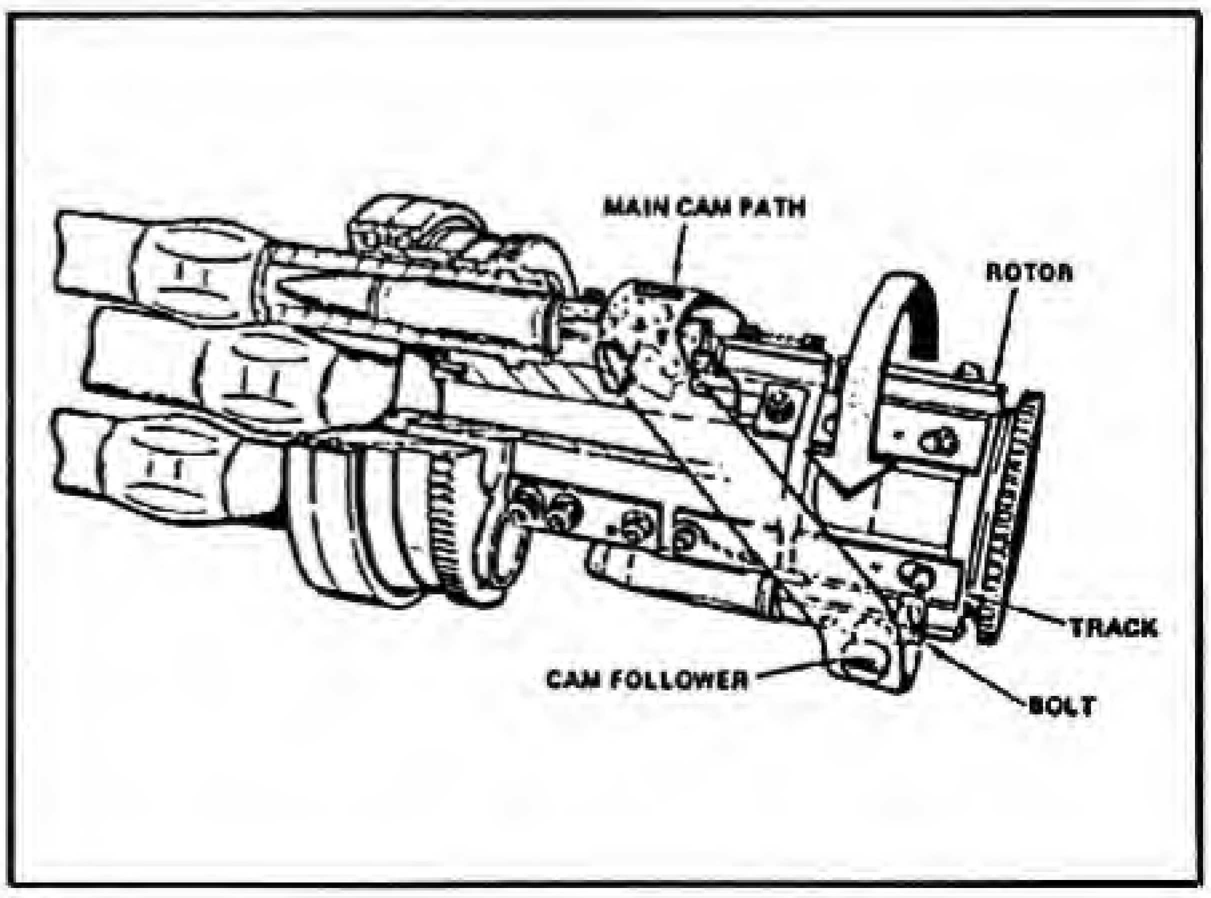
Basic Gatling Principle


3
2
1
4
6
5
1. Locked Bolt in Firing Position
2. Firing Contact Assembly
3. Locking Cam
4. Main Cam Path
5. Feed Position
6. Ejection Position

Bolt Cycle in Housing

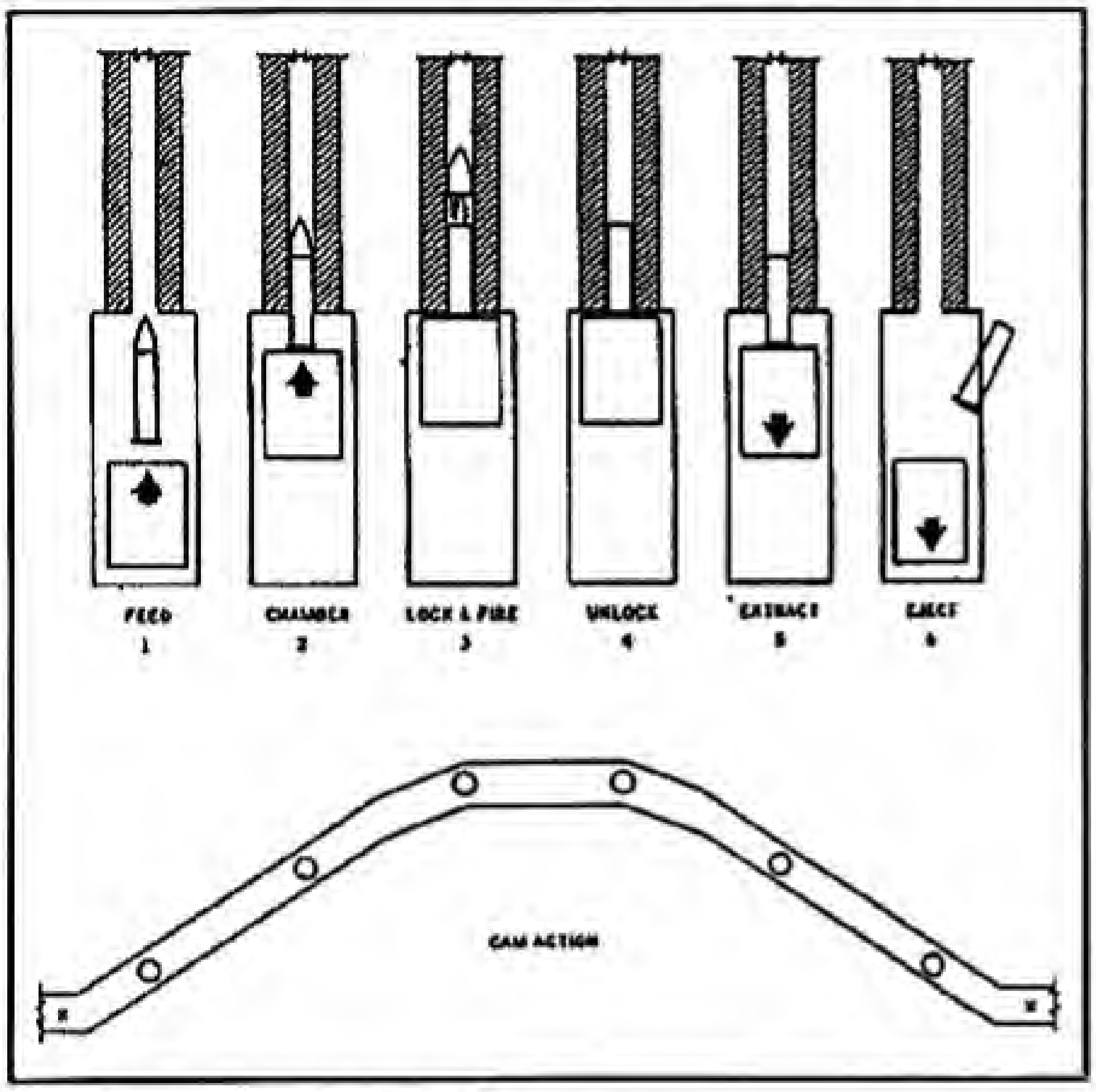
Forward dwell keeps the bolt in its "in-battery" positions for locking, firing and unlocking. It contains separate radial cams for these lock/unlock features. Rear dwell keeps the bolt to the rear of the gun where ejection and feeding take place. As viewed from the rear of the gun, forward dwell extends from 1:00 to 11:00 o'clock, and rear dwell from 7:00 to 5:00 o'clock.

Another illustration to better understand the Vulcan cycle, consider that the Vulcan operates as if it were six separate ordinary single barrel guns held in a circular cluster and rotated. On the outside of this cluster would be six stations that do not move. The first station inserts a new cartridge into each gun as it passes this station.


MAIN CAM PATH
ROTOR
TRACK
CAM FOLLOWER
BOLT

A fixed 45° cam at station two pushes this gun's bolt and ammo toward battery, and chambers the round. Station three locks the breech and fires the round. Station four unlocks the breech.

The second 45° cams as station five pulls the bolt and case out of the chamber. Station six ejects the case from this gun. The single gun and bolt then rotates to station one to repeat.



Bolt Operation and Cam Action

All six guns follow this cycle behind each other in their rotating cluster passing the six stations in turn; all performing one of the operations at any one time.

This arrangement presents six guns to fire six shots in the same time as required for one ordinary gun to fire one shot. If one ordinary gun can fire 1000 spm by itself, then the Vulcan gun, as just described can fire 6000 spm.

Vulcan Gun Bolt Assembly

Gun bolts are the "hearts" of all guns; so it is with Vulcan. Vulcan has six gun bolts and six hearts all working at the same time. They are the only longitudinally moving assemblies in the gun, and provide the ramming and the extracting gun features. They rotate with the gun rotor and barrels, and can slide fore and aft at their rotor locations. A main cam, in the fixed gun housing, is engaged by the bolt rollers; this cam governs the fore-aft travel of the bolts during the gun cycle.

The gun bolts also provide the breech lock and have provisions for both locking and unlocking. They contain the insulated firing pins and, the means for extending and retracting the pins. The bolt's extractor lip is always engaged with the cartridge's extractor groove throughout the complete gun cycle.

Breech Lock. Each gun bolt assembly is fed a new cartridge by the gun's feeder, when the bolt is at the rear of the gun. The cartridge is retained in the bolt's extractor lip, which is fixed (no springs used); it is kept in the lip throughout the entire gun cycle up to ejection.

While the gun rotates, the cartridge is rammed into the barrel chamber, and the breech is locked, by the gun bolt lock block. The bolt's lock block is cammed into the lock recess in the rotor at the end of the ram stroke. This locks the bolt body and allows the body to transmit rear breech firing loads to the rotor via this lock block.

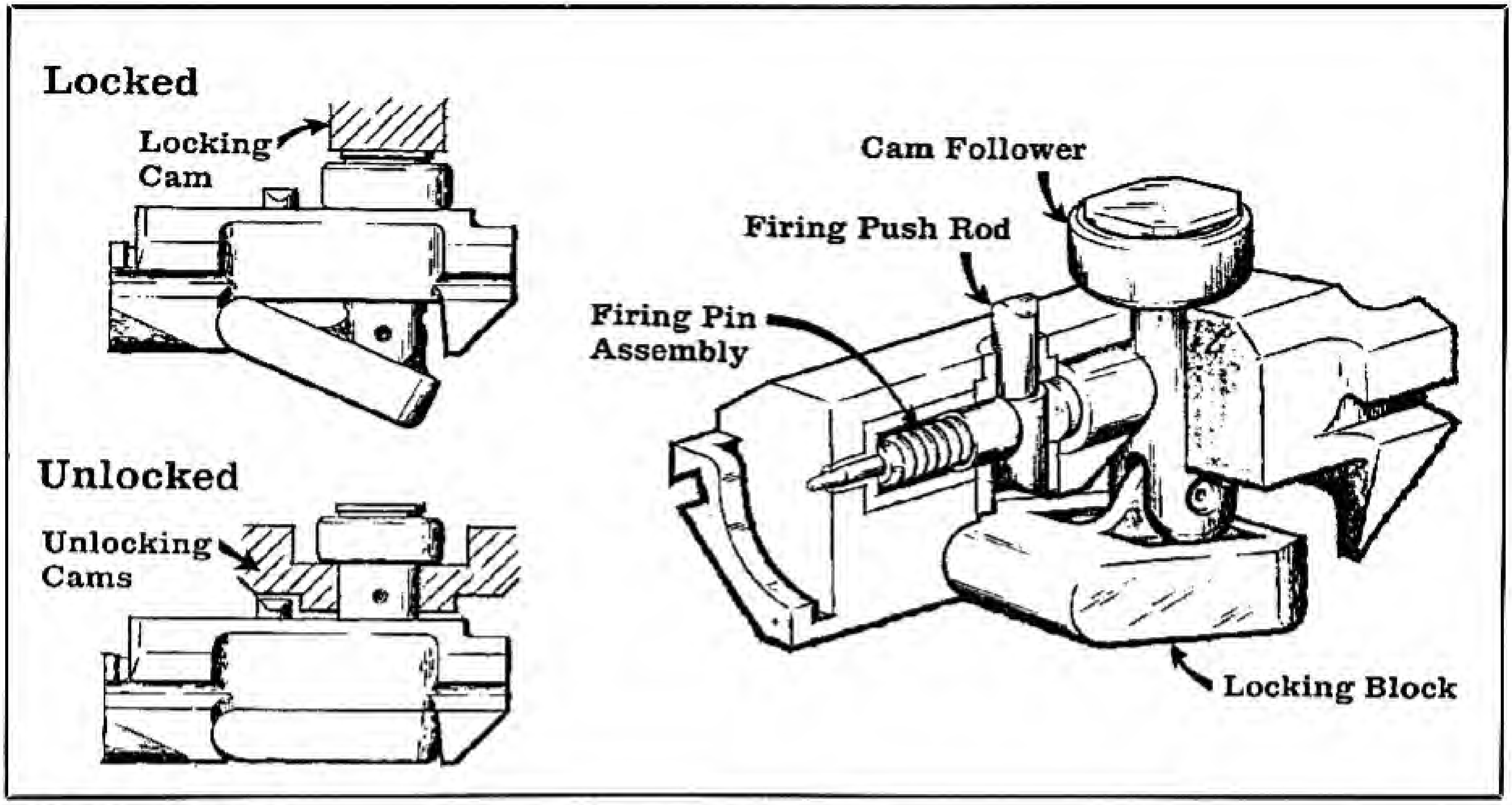
The bolt remains locked throughout the firing 60° section, here the projectile leaves the barrel and the breech gas pressures decrease. Unlocking now commences. The lock block is cammed out of the rotor's lock recess permitting the bolt assembly to begin its rearward stroke while extracting the fired case from the chamber. (There are no initial extracting devices used.) At the completion of this stroke, the case is ejected radially from the gun, rolling tangentially out of the bolt face lip.

The bolt's lock block fits under the bolt. Its forward end is a one-half circle radius that fits into a mating surface on the bolt body. Near the rear and on top of the block is a raised section with an elongated hole.

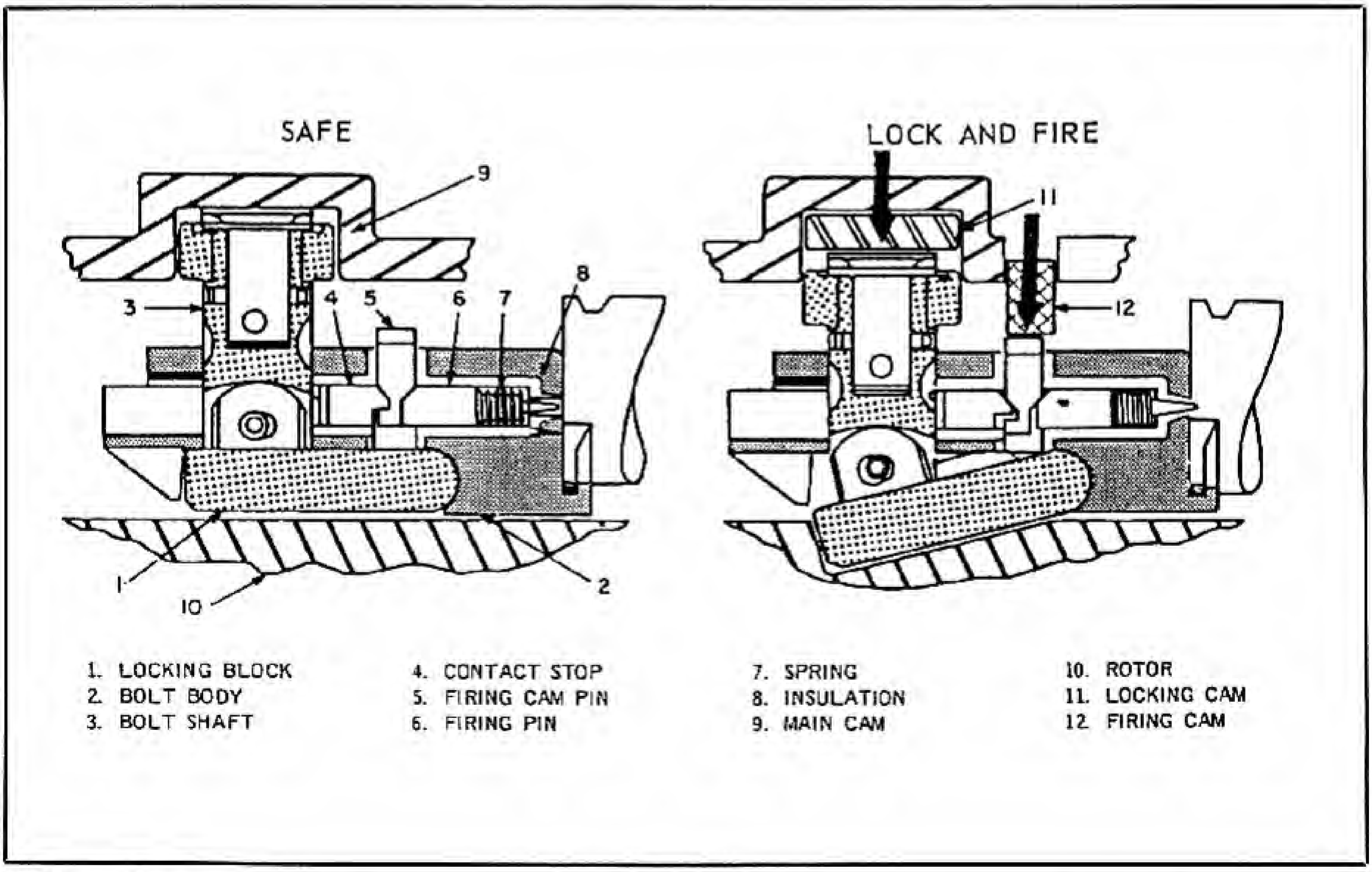
The lock block is secured to the bolt body by the forward radius, and by the bolt's roller shaft which is pinned to the rear-top of the lock block. All ports are precision machined so no springs or adjustments are used.

The roller shaft and lock block pinned assembly is therefore retained to the bolt body. This assembly is free to move from lock to unlock, and vice versa, positions when the bolt assembly is free of the gun. When in the gun, the lock is kept in an unlocked condition, since it rides on the bottom of the rotor's trackway during ram and extract.

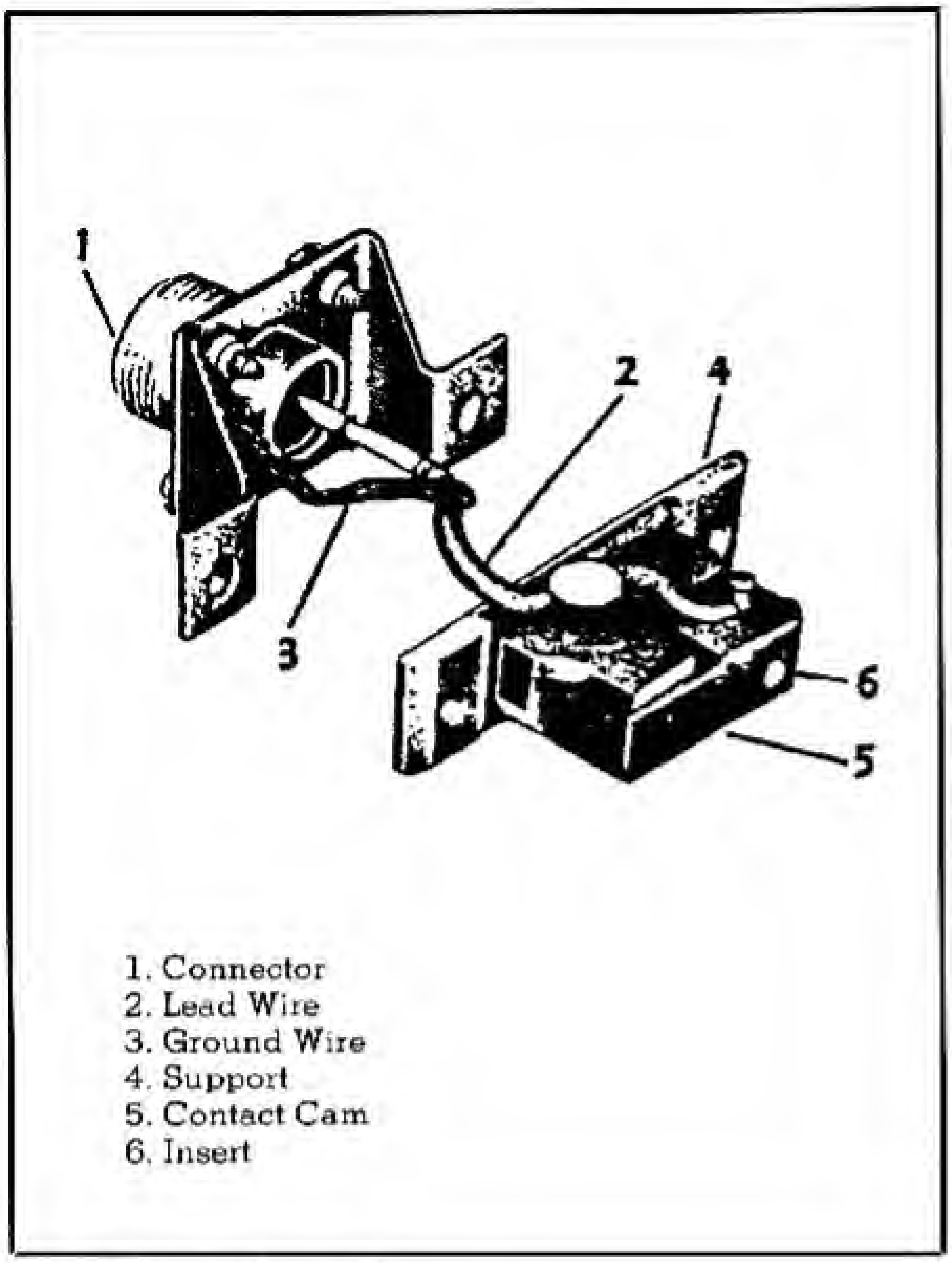
At the forward end of the bolt's travel it is cammed to a lock position; at the rearward end it is cammed to a semi-depressed position during automatic clearing (when used) at the end of a burst. A locking cam is located on the fixed housing. It is


Locked
Locking Cam
Unlocked
Unlocking Cams
Cam Follower
Firing Push Rod
Firing Pin Assembly
Locking Block

M61A1 Drop Lock Bolt


SAFE
LOCK AND FIRE
1
2
3
4
5
6
7
8
9
10
11
12
1. LOCKING BLOCK
2. BOLT BODY
3. BOLT SHAFT
4. CONTACT STOP
5. FIRING CAM PIN
6. FIRING PIN
7. SPRING
8. INSULATION
9. MAIN CAM
10. ROTOR
11. LOCKING CAM
12. FIRING CAM

Bolt Assembly



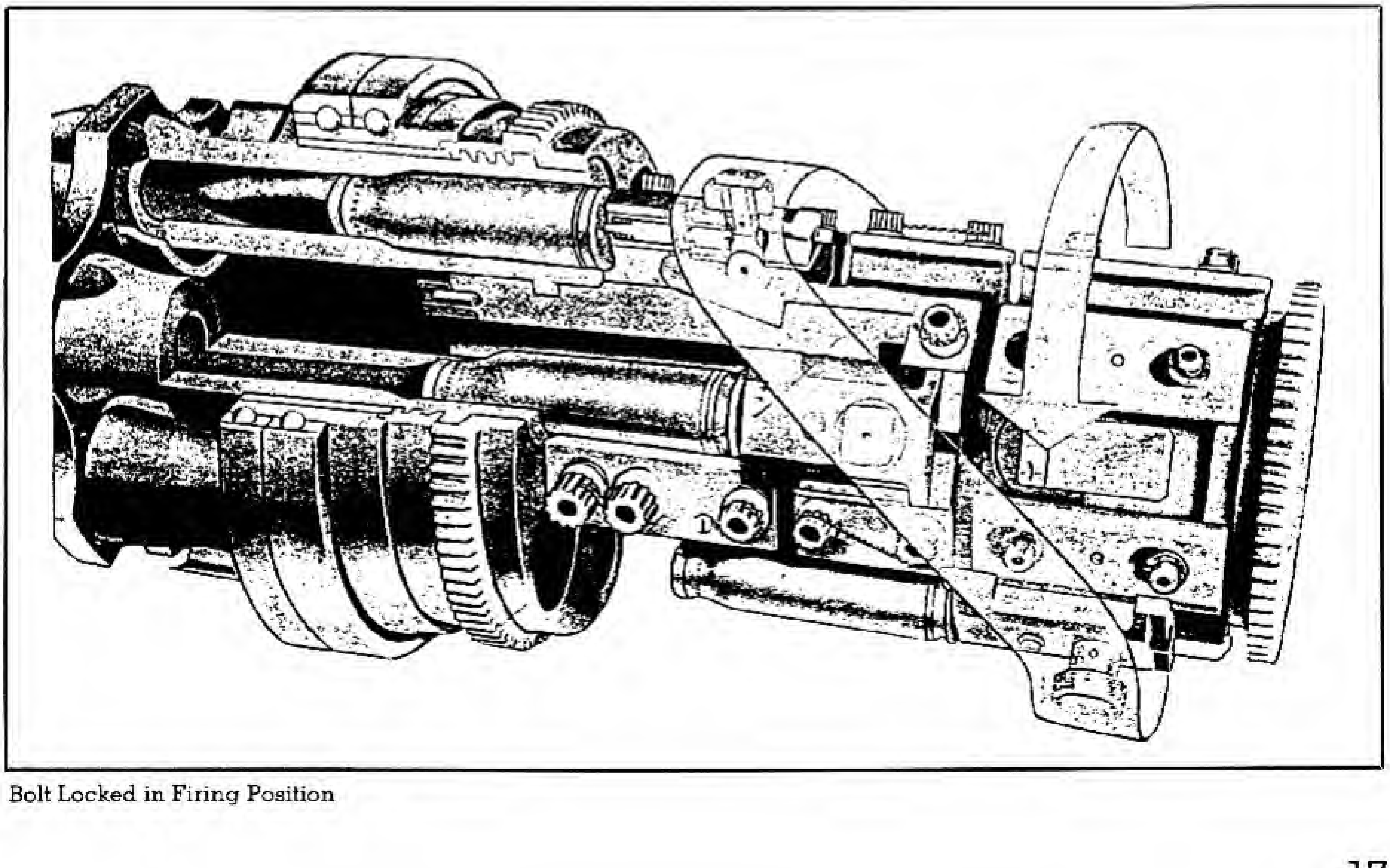
1. Connector
2. Lead Wire
3. Ground Wire
4. Support
5. Contact Cam
6. Insert

Firing Contact Assembly

actually bolted to the underside of the housing's main cam at the beginning of forward dwell. This lock cam is contacted by the top of the roller shaft immediately after finishing the ram stroke. As the gun rotates, the roller shaft is forced downward, or radially toward the center of the gun. The shaft is pinned to the lock block, so the lock block is forced down to its locked position. The front radiused edge of the block remains engaged to the bolt body's radius so that the lock block takes on an angular position of about 13°. It is down in the rear contacting the rotor lock well, and is up forward contacting the bolt body. The lock cam prevents the lock block from bouncing up out of engagement throughout the entire 60° firing sector.

Rearward breech loads are then transmitted from the breech face forward surface of the bolt body, to the radius surface that contacts the lock block, through the lock block to the rotor well. The circuit is complete since the rotor also contains and locks the barrels.

Unlocking takes place after the 60° firing sector. A fork like cam, bolted to the fixed gun housing extends to the underside of the bolt roller. The roller makes contact with this unlock cam and the lock block is lifted to its unlock position, unlocking the



Bolt Locked in Firing Position

breech so that extraction can begin.

The lock block configuration produces an overturning breech load to the bolt body face. This movement is taken out by the forward rotor tracks and the body's trackways. Similar overturning loads are produced during ramming and extracting which likewise are taken by the tracks and trackways.

Firing Pin. The electrical firing pin is a multi-piece design that is totally contained within the gun bolt body. The holes in the bolt body that hold these parts are electrically insulated. The operation is mechanical-electrical. The firing pin is mechanically cammed into contact with the cartridge primer at the time of finishing breech lock. Immediately, an electrical impulse is transferred to the primer to ignite it.

As breech pressure builds, the firing pin is allowed to retract. A small spring is used to keep it retracted during all other gun functions.

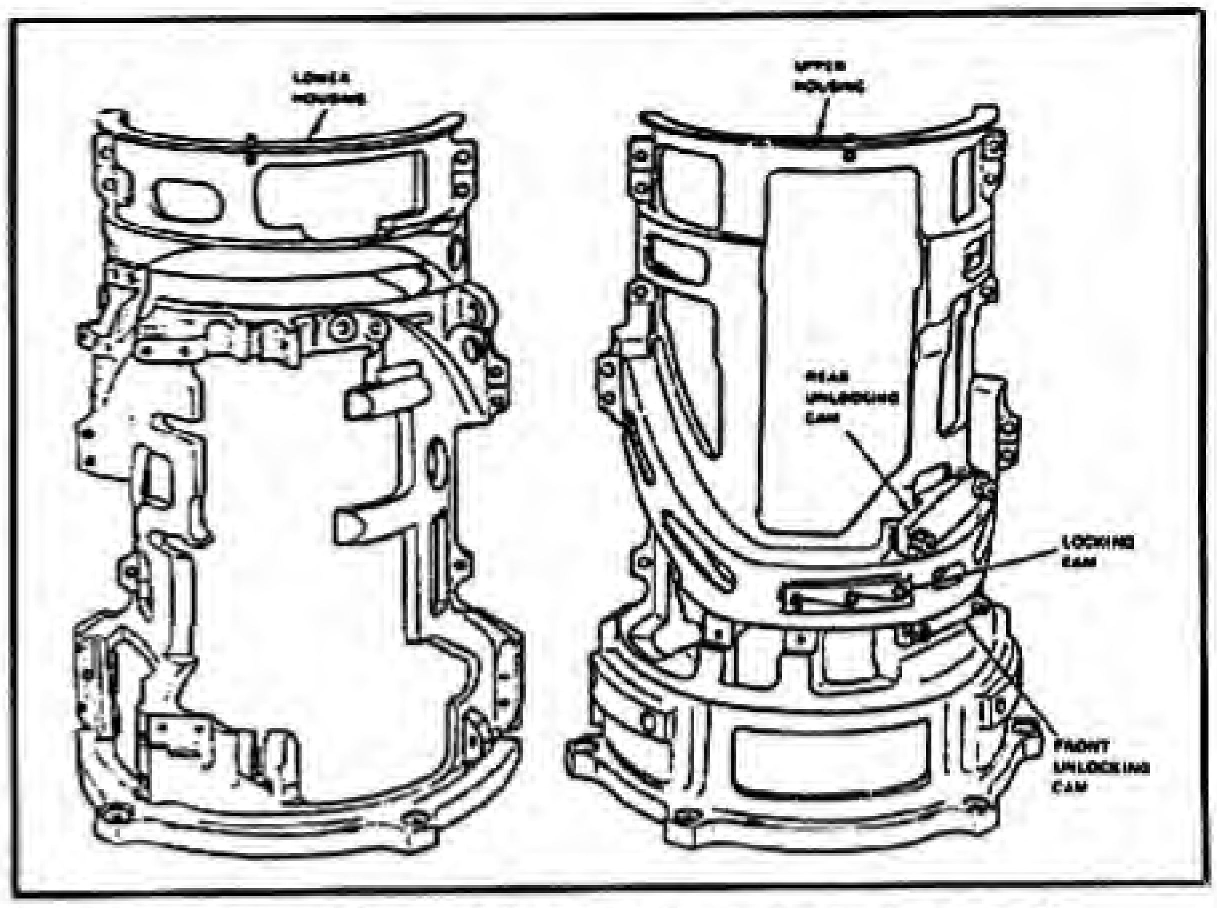
A safety feature is provided to prevent the firing pin from extending, and grounds the electrical impulse if the breech is not locked at the time of firing.

The firing pin has an ordinary tapered/spherical tip to ensure good contact with the primer cup and produces an ordinary mechanical primer indent. It is cammed out of the bolt body by a right angle vertical pin using simple 45° camming surfaces. The right angle pin is cammed down into the bolt body by the electrical firing cam assembly that is bolted to the fixed gun housing.

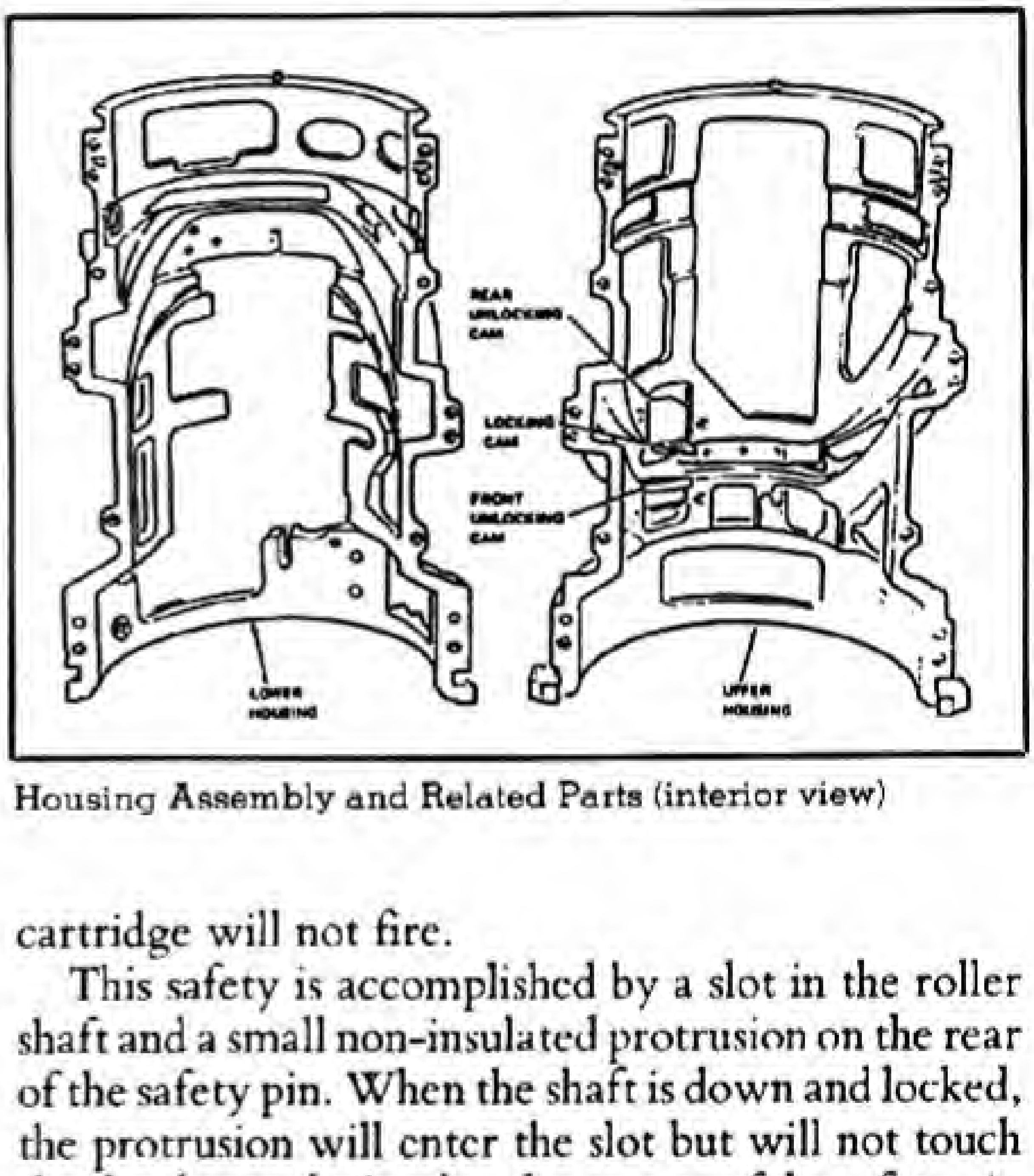
The safety pin is directly behind the firing pin, and is cammed to the rear by the vertical pin. A locking shoulder on the vertical pin engages a lip on the safety pin. This retains the vertical pin and keeps the three pins in proper positions at all times when the roller shaft and lock block are assembled.

The safety pin is cammed to the rear toward the roller shaft at the same time the firing pin is cammed forward. The safety pin contacts the roller shaft in one of two ways. If the roller shaft is down in its locked position, the safety pin will merely stop against the shaft and, the firing pin will fully protrude to fire the cartridge. When the safety pin contacts the locked roller shaft, the pin is insulated to prevent grounding out.

If for any reason the roller shaft is not down, and the breech is not locked, as the bolt reaches the firing section, then the safety pin will contact the roller shaft in a different manner and position on the shaft. The firing pin will not fully protrude, the electrical impulse will be grounded out to the shaft and the cartridge will not fire.



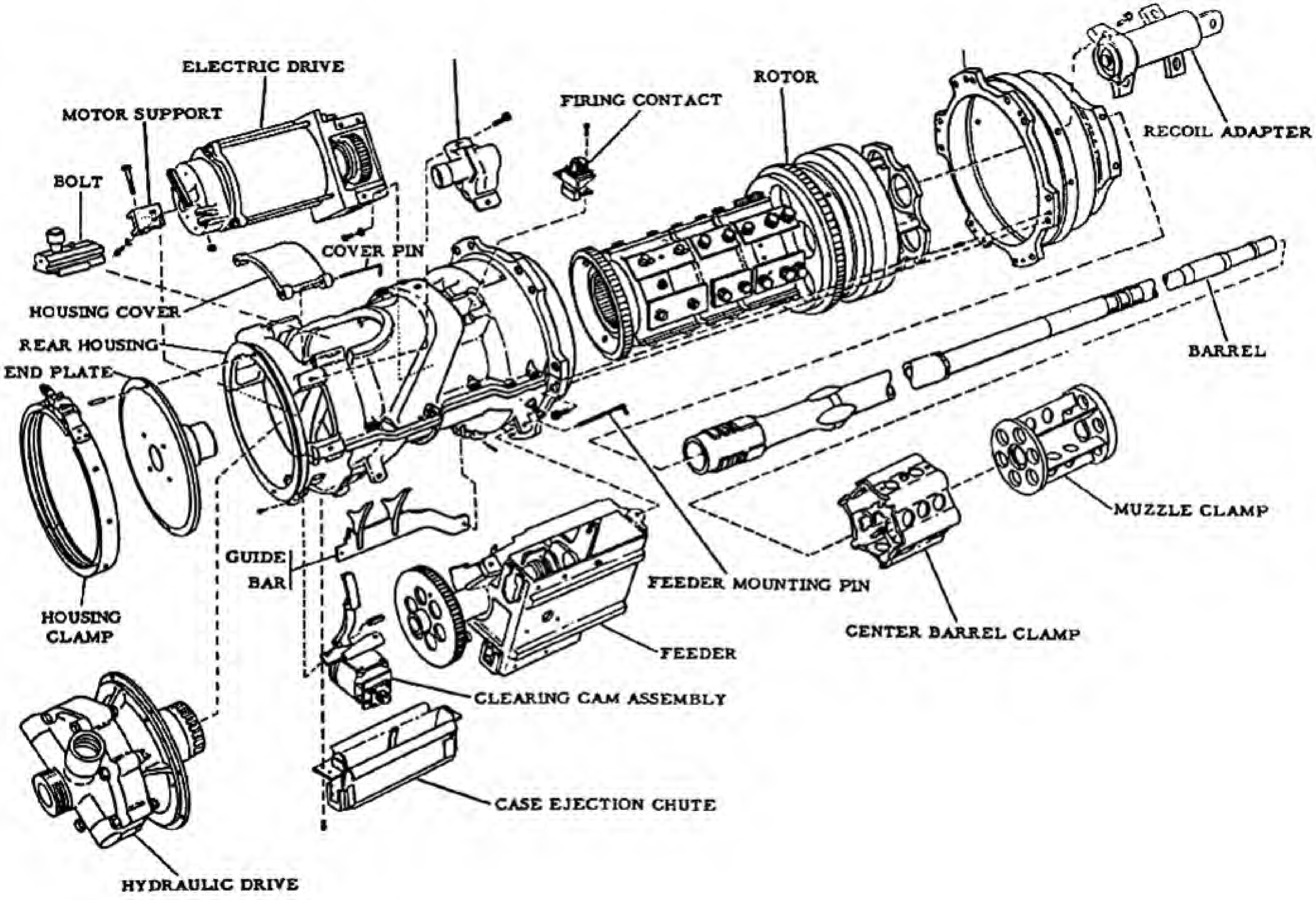
Housing Assembly and Related Parts (exterior view)



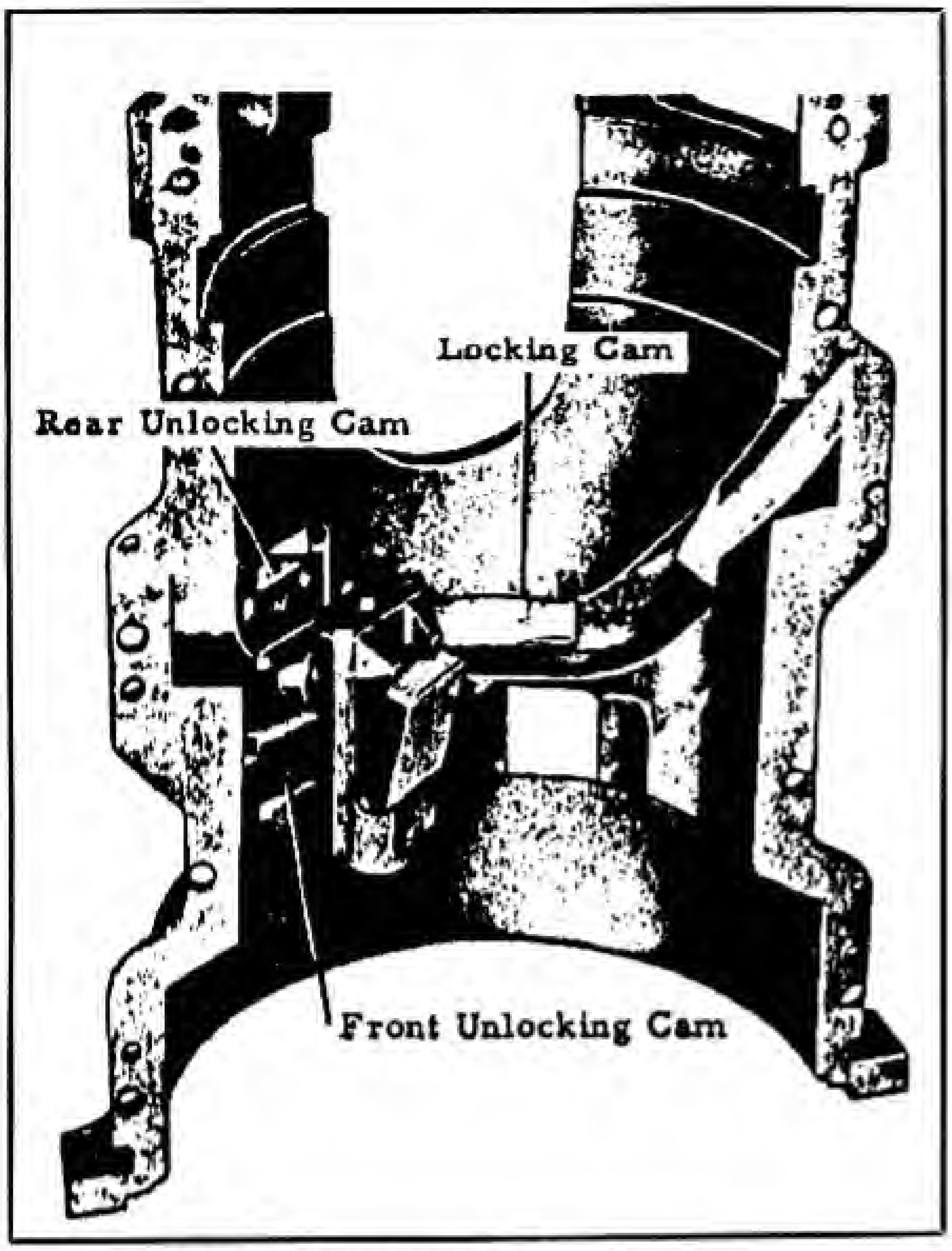
Housing Assembly and Related Parts (interior view)

This safety is accomplished by a slot in the roller shaft and a small non-insulated protrusion on the rear of the safety pin. When the shaft is down and locked, the protrusion will enter the slot but will not touch the slot due to the insulated rear part of the safety pin touching the shaft first and permitting firing. If the shaft is not down and locked, the safety pin protrusion will touch the shaft first and prevent firing pin extension. The safety pin will also ground out and prevent firing.

Electrical voltage is applied to the vertical firing pin after it is cammed down. Both the mechanical action and the electrical charge are provided by a single insulated cam at the beginning of the 60° firing sector. This firing cam assembly is attached to the housing. It has a standard electrical connector and a single electrical lead from the connector to the cam.


ELECTRIC DRIVE
MOTOR SUPPORT
BOLT
FIRING CONTACT
ROTOR
RECOIL ADAPTER
COVER PIN
HOUSING COVER
REAR HOUSING
END PLATE
BARREL
MUZZLE CLAMP
GUIDE BAR
FEEDER MOUNTING PIN
HOUSING CLAMP
CENTER BARREL CLAMP
FEEDER
CLEARING CAM ASSEMBLY
CASE EJECTION CHUTE
HYDRAULIC DRIVE

Components of 20mm M61 Gun



Position of Bolt at Unlocking Cams

The cam is heavily spring loaded to its open position. The cam is a high strength plastic molding with a brass insert. The insert has a connection means on its side for fastening the lead.

On the surface of the cam that contacts the bolt's vertical pin, the insert is flush with this surface near the end of the contact surface. The action is that as the vertical pin approaches and contacts this surface, it is cammed down mechanically. A gun rotation continues the vertical pin still down then touches the electrical insert sending the electrical impulse to the firing pin and the prime to fire the cartridge. The contact surface then ends. The cartridge is fired; and, the firing pin, vertical pin and safety pin are returned to their retracted positions ready for the next firing cycle.

Physical Description of Other Vulcan Gun Parts

The Vulcan is a rotary gun. All gun components rotate except the main housing (and drive, feeder and recoil adapters all of which are attached to the housing). The drive, electric or hydraulic, supplies the power to accelerate the rotating parts to full speed and to keep them at full speed throughout the burst.

Barrels. The gun uses six barrels, each being five feet long. The barrels are easily slipped into the six holes machined in front of the rotor. A one-third twist of each barrel locks them to the rotor so that they cannot move in or out (a bayonet lock).

Two barrel clamps are used, one at mid-length (called the center barrel clamp) and the other at the muzzles. The center clamp has a key for each barrel that prevents any barrel twisting motion. This keeps each barrel locked fore-aft to the rotor. Also, at the center clamp position, each barrel is equidistant from each neighboring barrel, forming a true cylinder of the six barrels.

The muzzle clamp also locks and positions each barrel's muzzle accurately to each other. This permits each muzzle to aim at the target as it is rotated into firing position and fired.

The barrel cluster, however, is gradually tapered. The rotor barrel holes are machined to produce a slight cone to the cluster. Each barrel is coned toward the center or rotation of the cluster by about three-fourths of a degree. The slight cone is designed into the cluster to minimize the target bias shift as the gun is fired at various gun rates such as 2000 spm and 6000 spm. Since the tangential load on the projectile is greater at the higher gun speed, the projectile will be thrown further to the side at the higher speed than it would at the lower speed. The barrel cluster cone minimizes this effect permitting the same aiming point at all firing rates with just a small bias shift of about two mils on the target.

The barrels are made of Chromium-Moly-Vanadium (CrMoV) and are gain twist. The chambers are chrome-plated. All barrels are assembled to the gun without the need for headspace adjustment since the barrel lock shoulders in each rotor hole are precision machined to each other to the main bearing shoulder and to the gun bolt locking surfaces.

Rotor Assembly. The Rotor Assembly is the main structural member inside the gun housing. The rotor secures and positions the barrels and rotates with the barrels.

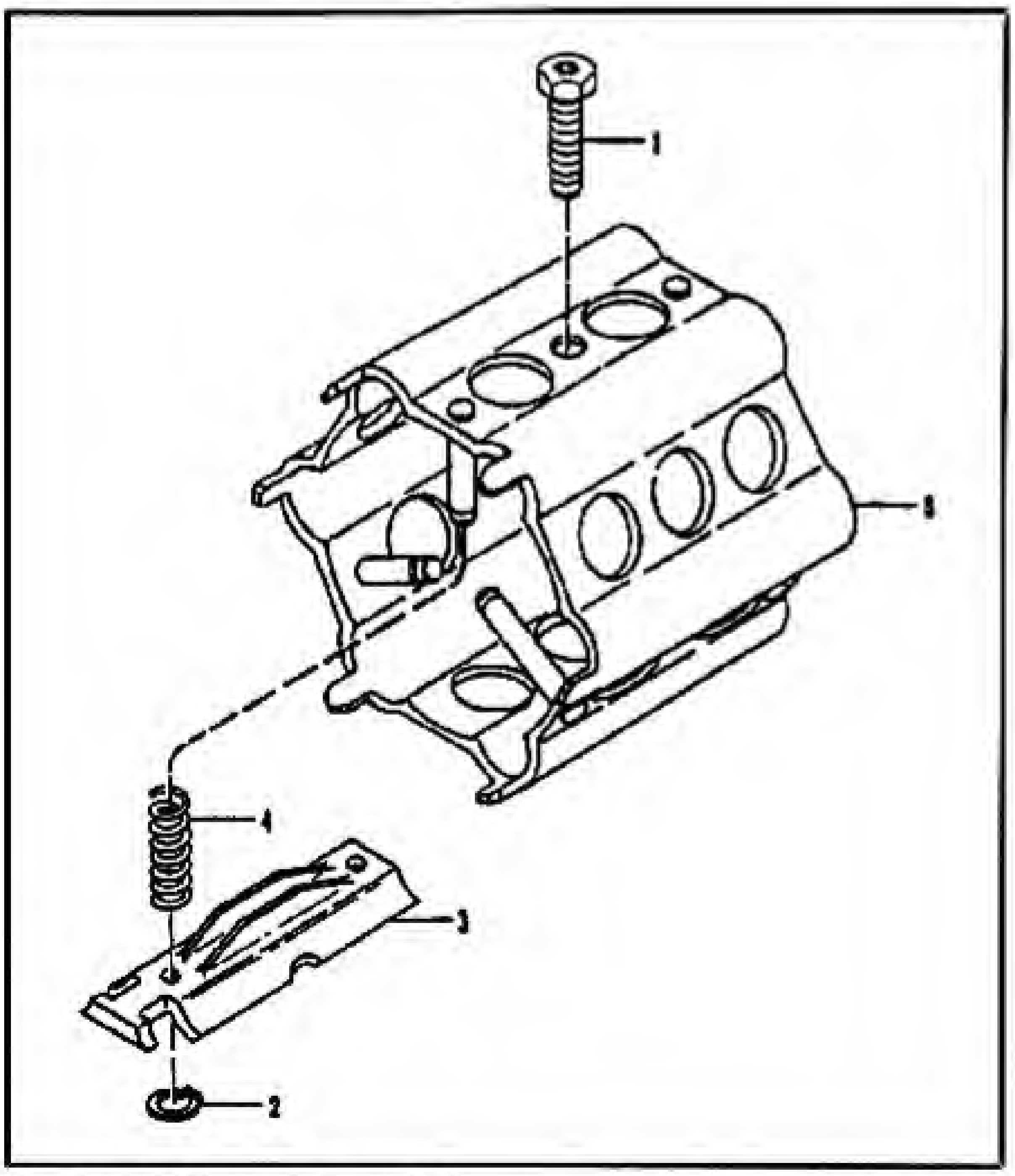
The major double row of ball bearings on the forward end of the rotor transmit both radial and longitudal breech loads to the gun housing. A small internal needle bearing is located to the rear of the rotor. It transmits only radial loads to the gun housing, via the end plate. The rotor is positioned radially inside the gun housing by these two bearings and the rear end plate. It is positioned fore-aft by the large forward bearing and the accompanying shoulders on the rotor and on the housing. This allows very accurate location of the rotor so that gun functions of locking, unlocking, feeding, ejection, etc. can be accomplished without adjustments.

There are two gears on the rotor. The forward one meshes with the electric drive output gear. The rear rotor gear meshes with the feeder's gear. The hydraulic drives transmit through an internal spline slightly forward of the rear bearing inside the rotor and replaces the end plate when used.

The rotor provides six track ways for the six gun bolts to ram forward and to extract rearward. The forward tracks are bolted to the rotor. The rear tracks have a quick disconnect feature for installing or removing the gun bolts.

Each gun bolt has a drop lock block that transmits breech load from the bolt face to the rotor's locking surfaces. This establishes the integrity of the gun's six breech locks since both the barrel retaining lugs and the gun bolt locking surfaces are in the rotor and about three inches apart.

At the rear of the rotor in each trackway are clearance cuts for the bolt's lock blocks, that are depressed by the clearing sector and clearing cam used during automatic gun clearing.



Exploded View of Barrel Clamp

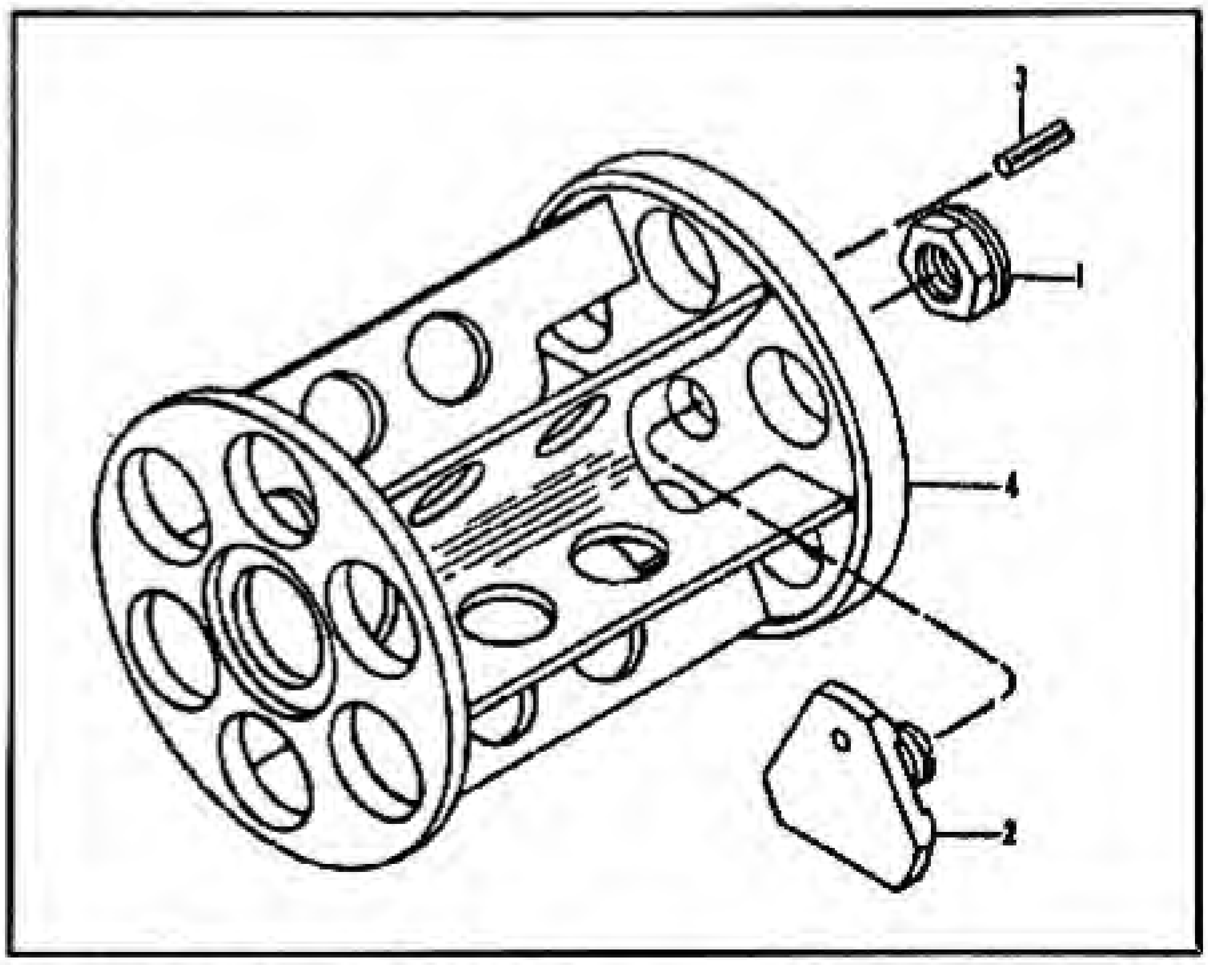
Housing Assembly. The gun's housing is a split cylindrical steel casting, bolted together that constrains the gun's rotating rotor, barrels and gun bolts. The housing is stationary, it does not rotate. It does move 0.250 inches in recoil (via the recoil adapters) when a round fires.

The main cam is accurately machined in the inside diameter of the housing to direct the gun bolts through the gun functions from feeding, ramming, locking, firing, unlocking, extracting and ejecting. The acceleration and deacceleration parts of the main cam are important to keep gun torque to a minimum while serving on gun part life by being of a cycloipal constant force form.

All other stationary gun parts are bolted to the housing such as the lock and unlock cams, the firing cam and the automatic clearing sector when used.

The gun rotor without gun bolts is installed into the housing by moving it rearward through the housing's largest diameter. The forward bearing is attached to the rotor beforehand. Once the rotor assembly is inside on the housing's forward shoulder, the forward retainer is bolted to the front flange of the housing. The rear end plate can now be inserted into the rotor's needle bearing. The end plate is also mated with the housing rear shoulder with a rabbit fit. A Marlin clamp locks the end plate to housing.

The gun is attached to its mount or system or aircraft by three points. The two points forward are provided, one each by the recoil adapters. The singular rear mount is a cylindrical hole in the center of the end plate, allowing a fixed ball shape with shaft to be

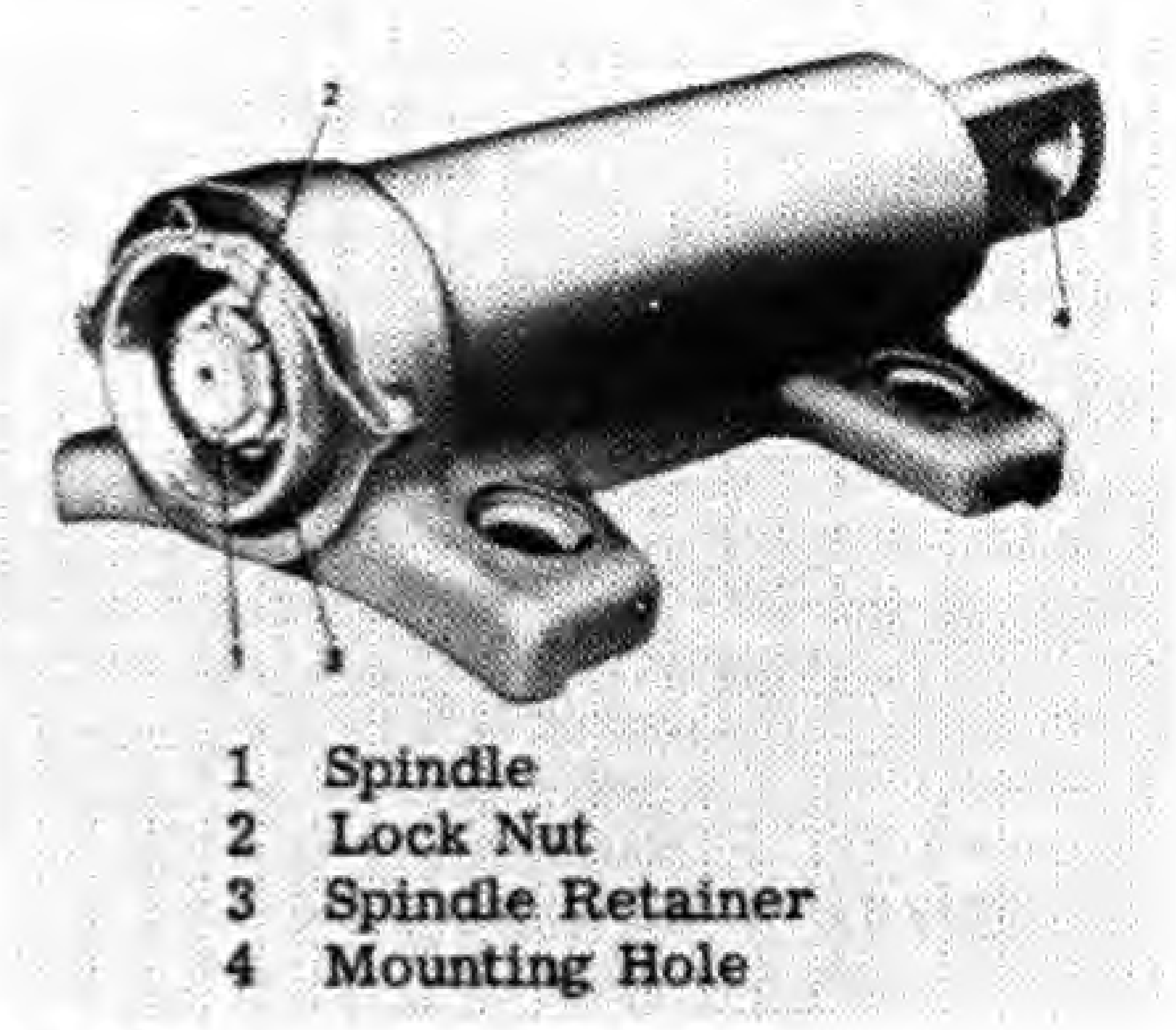


Exploded View of Muzzle Clamp

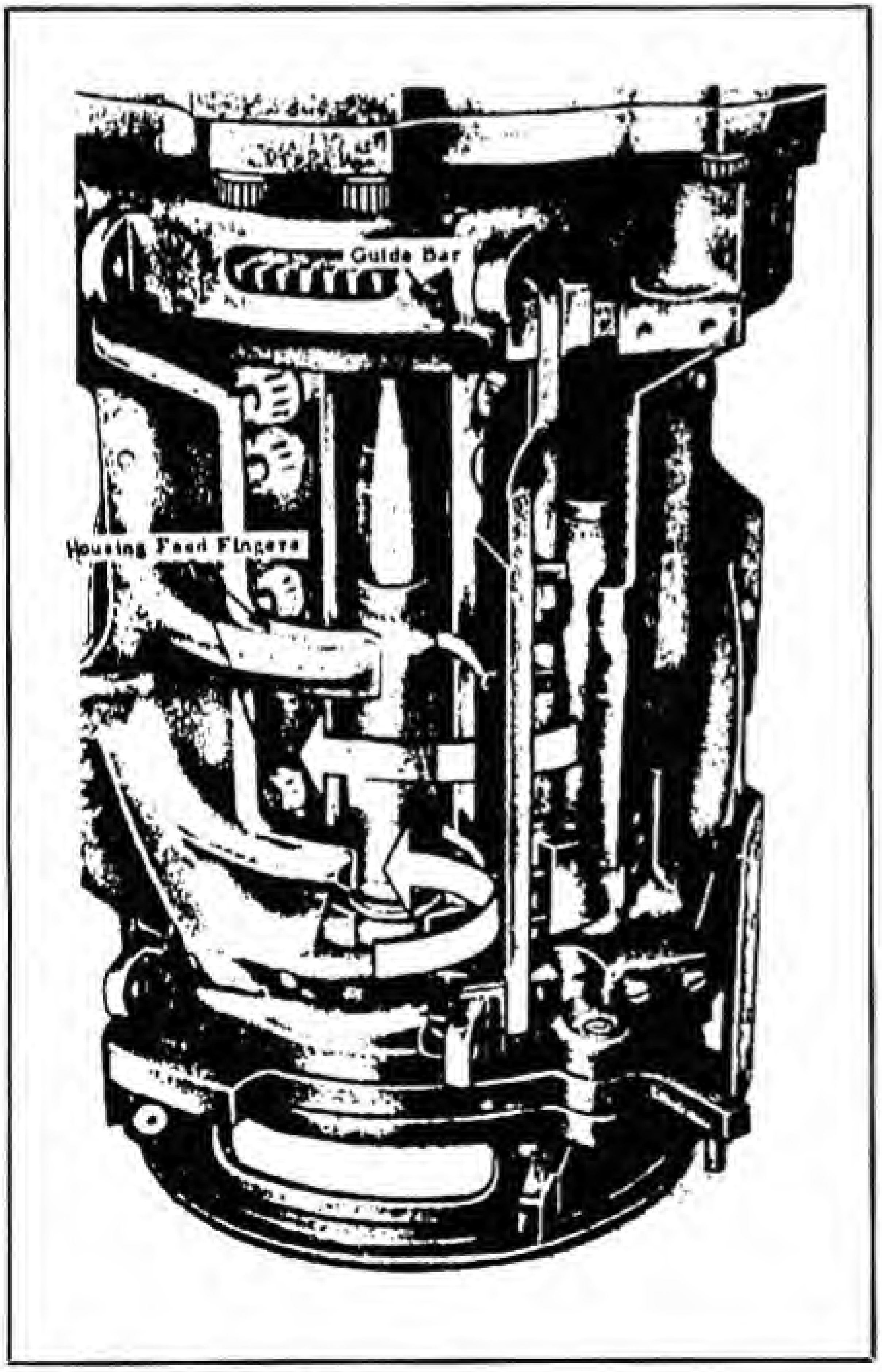
inserted into the hole and its shaft retained to ground.

Recoil Adapter. The two forward mounts use quick disconnect pins that are transverse to the axis of the gun. There is one pin on each side of the gun. The pins' centerlines pass slightly below the centerline of the firing barrel. These mounting pins take out recoil and counterrecoil; the shoulders take out transverse loads of the gun. This allows the gun to rotate about the axis of the pins. By connecting the rear ball mount to the gun, those gun movements about the pin are restrained. The rear ball mount takes out only radial loads through the axis of the ball mount shaft and allows fore-aft movement of the gun via the two recoil adapters springs.

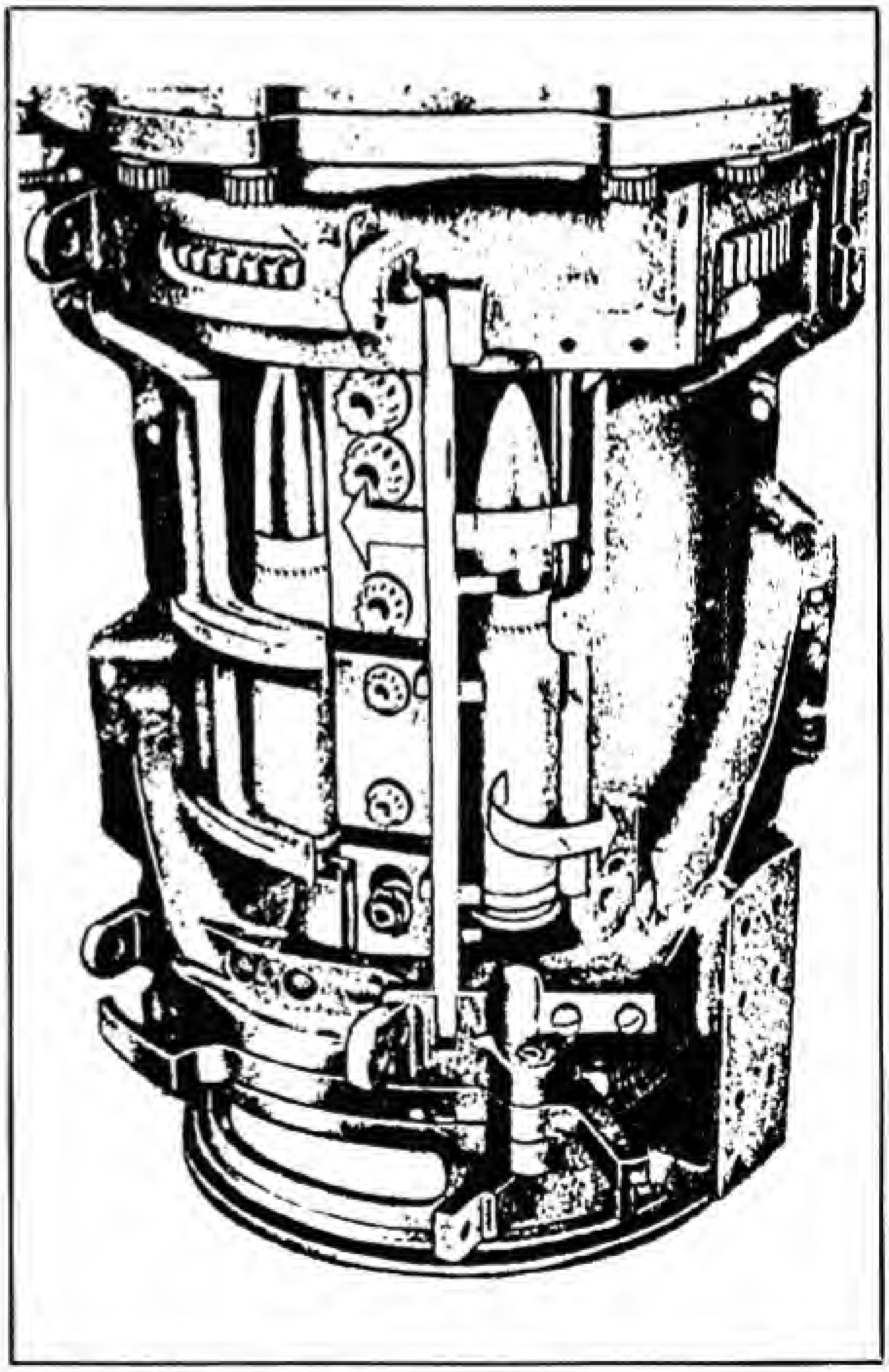
The two recoil adapters are assembled on the housing and bolted. Inside each adapter is a high gradient Edgewater buffer spring. The springs are made up of individual male and female stub washers that interact against each other as the gun recoils and



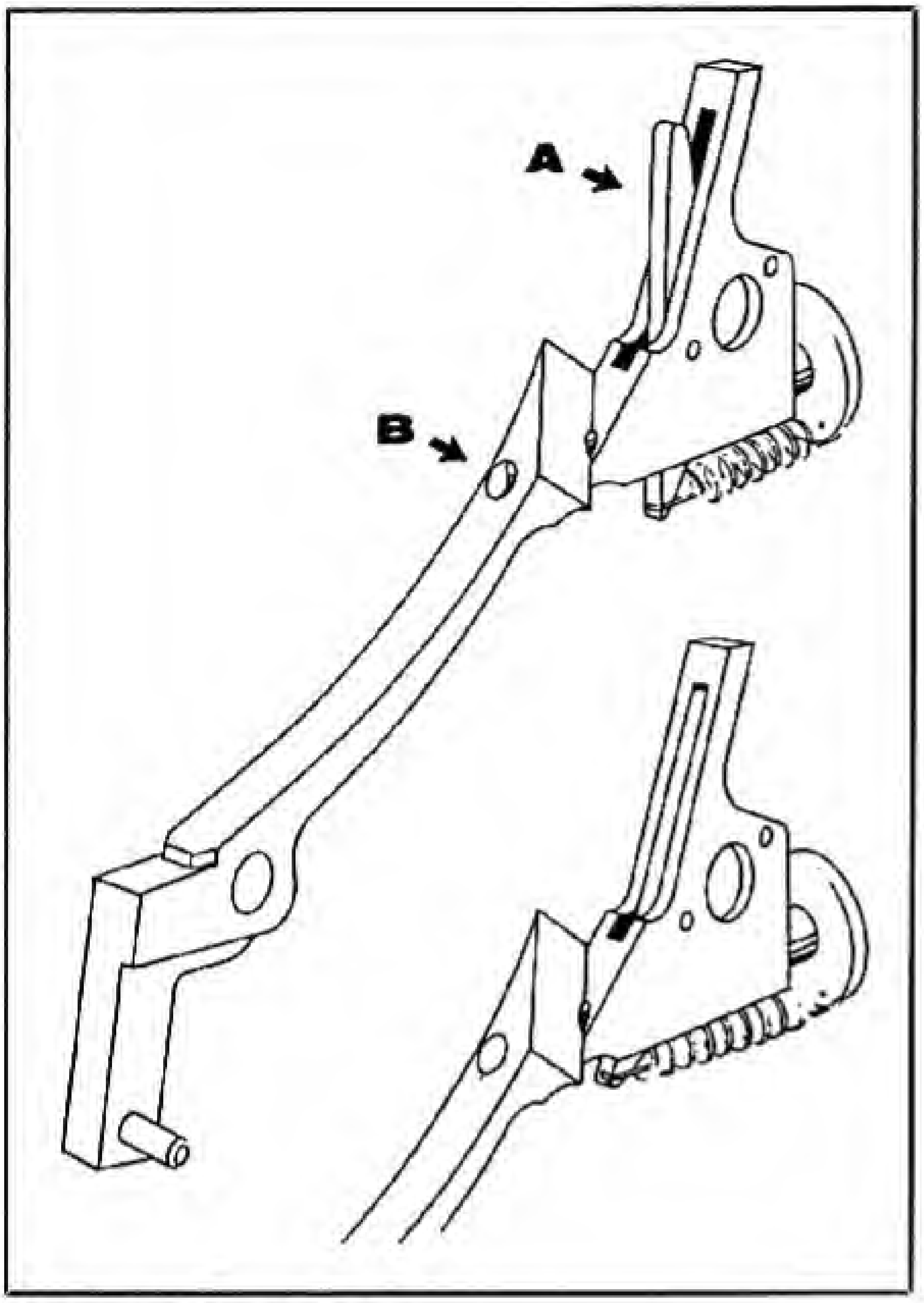
Recoil Adapter



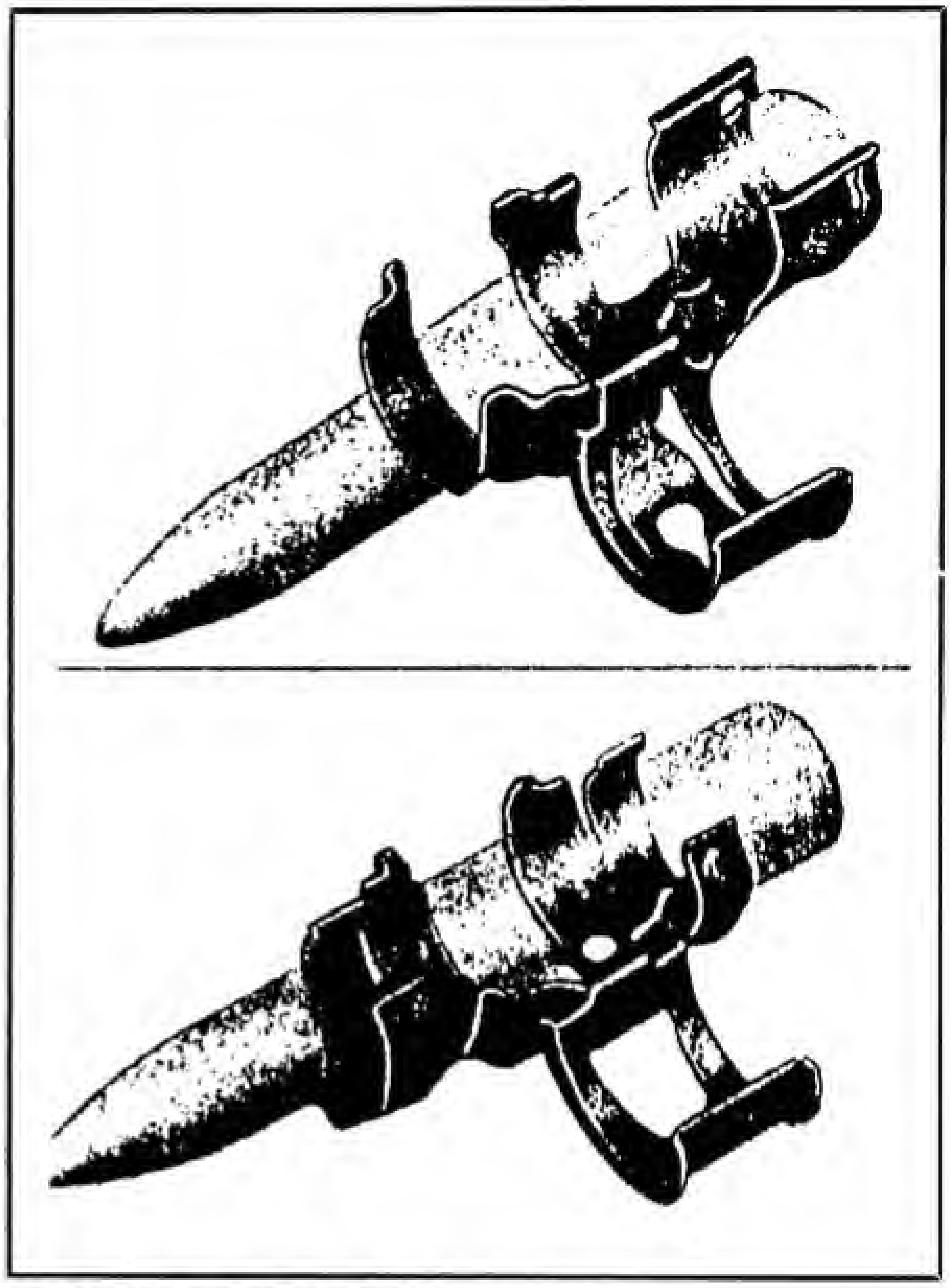
Round Guided into Bolt



Ejection of Empty Round



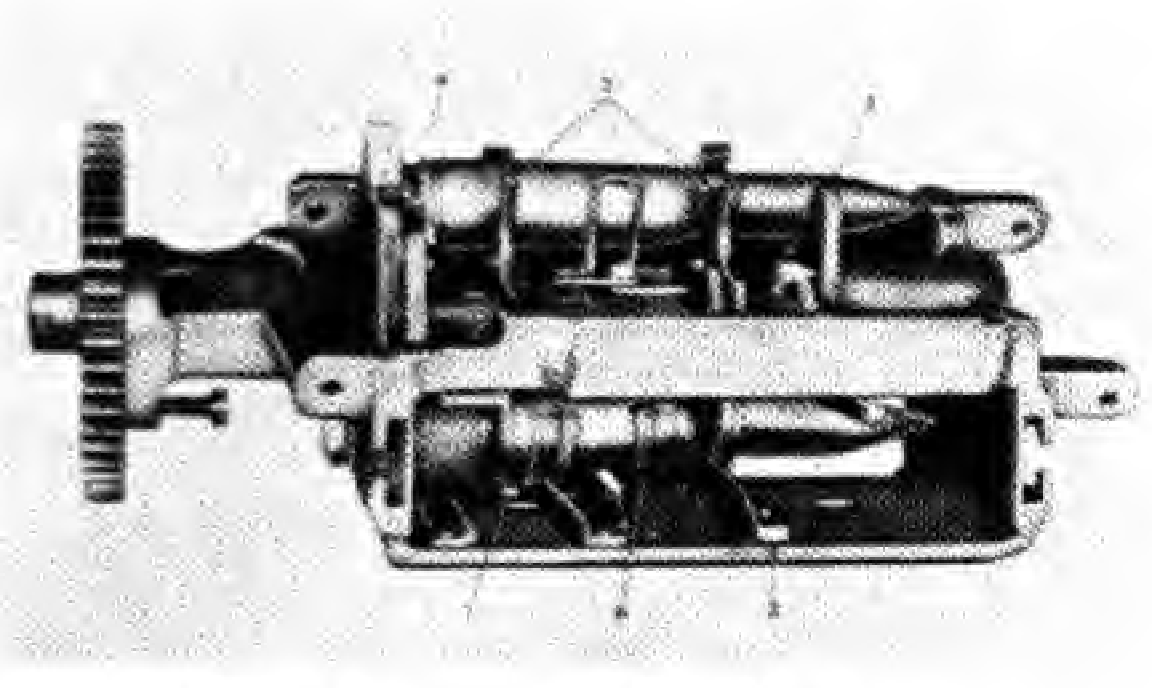
Automatic Clearing Sector



T76 Link (Top) and T99 Link (Bottom)

counterrecoils. A high damping force is created, so that during steady firing a positive reduced force and excursion of the gun fore-aft is experienced. During the speed transients at the beginning and at the end of a burst, higher loads with a few complete reverse cycles are seen. The average steady recoil force at 6000 spm is about 3000 pounds. The surge during transients will vary upward to 5500 pounds fore-aft.

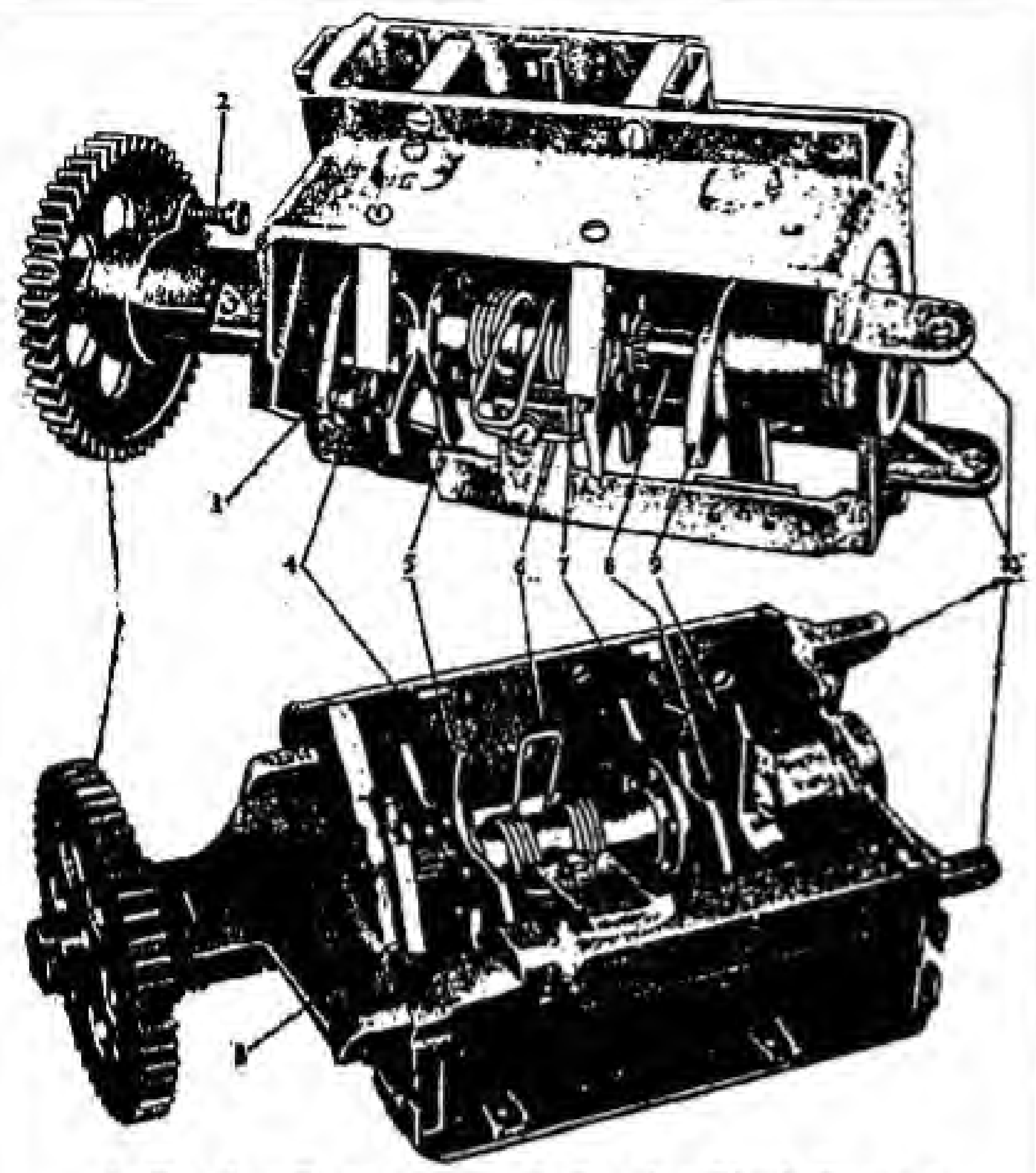
Guide Bar. At the feed and ejection position on the housing is located a guide bar and a case ejection chute. The guide bar is attached to the housing with roll-pins. On the guide bar are two ammo guides that somewhat tangentially (to the rotor) guide new cartridges into the gun, and fired cases (and duds) out of the gun. The feed and ejection take place during rear dwell where the bolts are rotating but are not moving longitudinally. A small rim guide on the feed side of the guide bar assures that the ammo will move fore-aft with the gun, and will be perfectly aligned with the bolt's extractor lip as the ammo enters into the bolt face.



1. Stripper
2. Sprockets
3. Front Guide
4. Rear Guide
5. Noise Guide
6. Link

Feeder Stripping Action

On the ejection side of the guide bar, the spent ammo and duds are cammed out of the bolt face (and gun) by the same guides. A case chute, bolted to the gun housing passes the cases or duds out of the gun in



1. Feeder Gear
2. Indexing Pin
3. Rear Guide
4. Stripper
5. Rear Sprocket
6. Feeder Shaft Spring
7. Front Guide
8. Feeder Shaft
9. Nose Guide
10. Mounting Pin Holes

Feeder M1 (T8E1) Top and Feeder T14 Bottom

a finite ejection path, with case velocities up to 20 feet per second at full firing rate of 6000 spm.

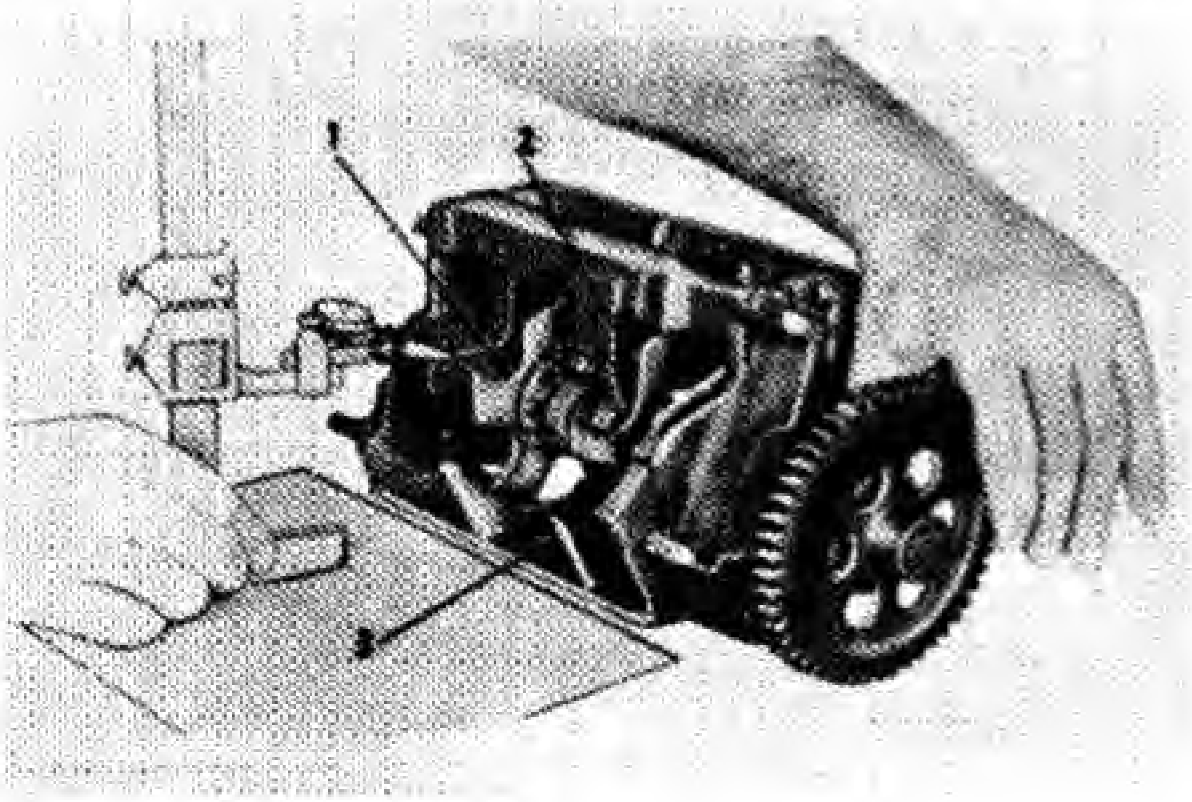
Clearing Cam and Sector Assembly. At the rear of the gun housing is the automatic gun clearing cam and sector assembly. The cam is a circular machined groove on the inside diameter of the housing. The sector assembly is made up of a solenoid and an external segment of the circular cam path. The solenoid lowers the sector into the housing circular cam during automatic gun clearing, and extracts the sector during gun firing.

Automatic gun clearing for the Vulcan is the same as "hold-back" for other guns. It keeps all gun bolts and ammunition to the rear of the gun while the gun is stopped, as in an "open-bolt" condition. This prevents inadvert firings such as "cook-offs" when hot barrel chambers cook-off ammo propellants and explosives of "chambered" cartridges.

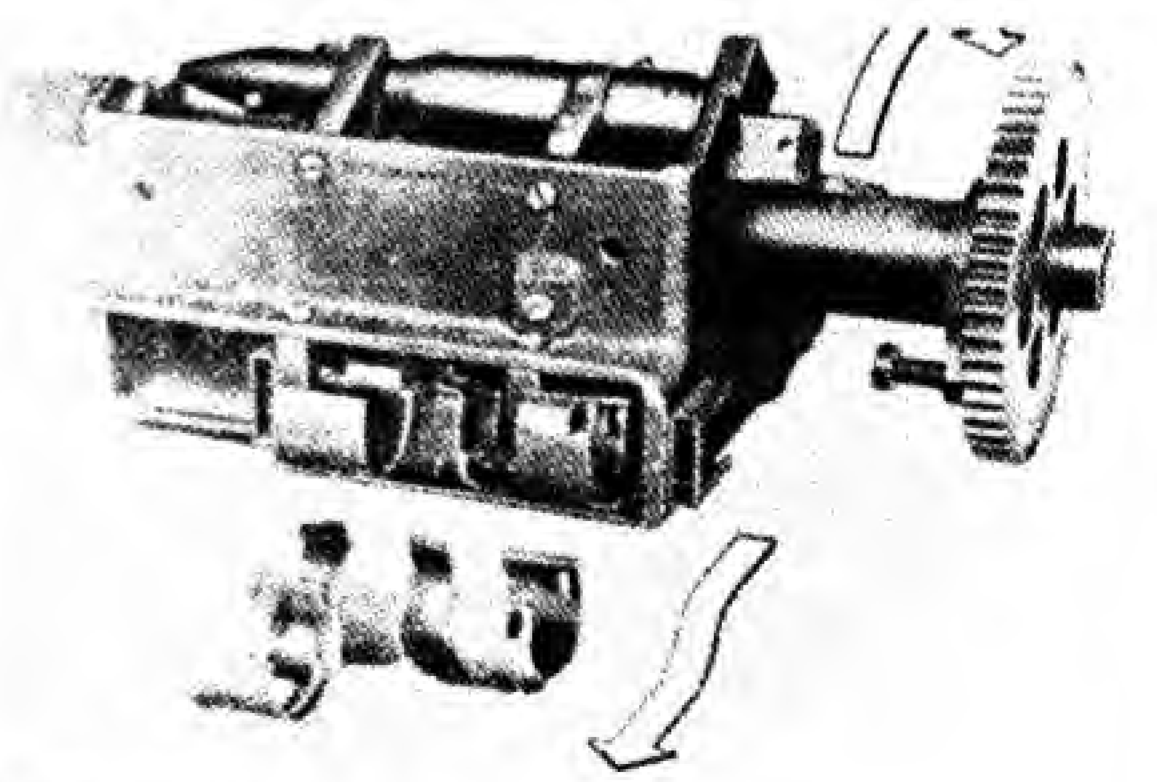
As the gun stops firing and starts to decrease speed, the solenoid inserts the sector into the rear dwell cam path. This forces the bolt's roller shaft inwards to a lesser diameter. The roller attains this lesser diameter at the end of rear dwell when it already contains a new cartridge and is about to start its ram function. However, instead of ramming via the main cam, the bolt's roller is cammed to enter the circular clearing cam and stop in a hold back function as the gun comes to rest with open chambers free of cook-off hazards.

There are two types of automatic clearing used on the Vulcans. Besides the clearing sector assembly, there is a clearing gun feeder. This feeder automatically stops the flow of ammo into the gun as the speed of the gun decreases from a steady state firing rate of 6000 spm to zero firing rate. Since the flow of ammo is stopped at the feeder, while the gun is still rotating, all ammo already in the gun will be cycled out of the gun before it comes to rest leaving the gun free of ammo.

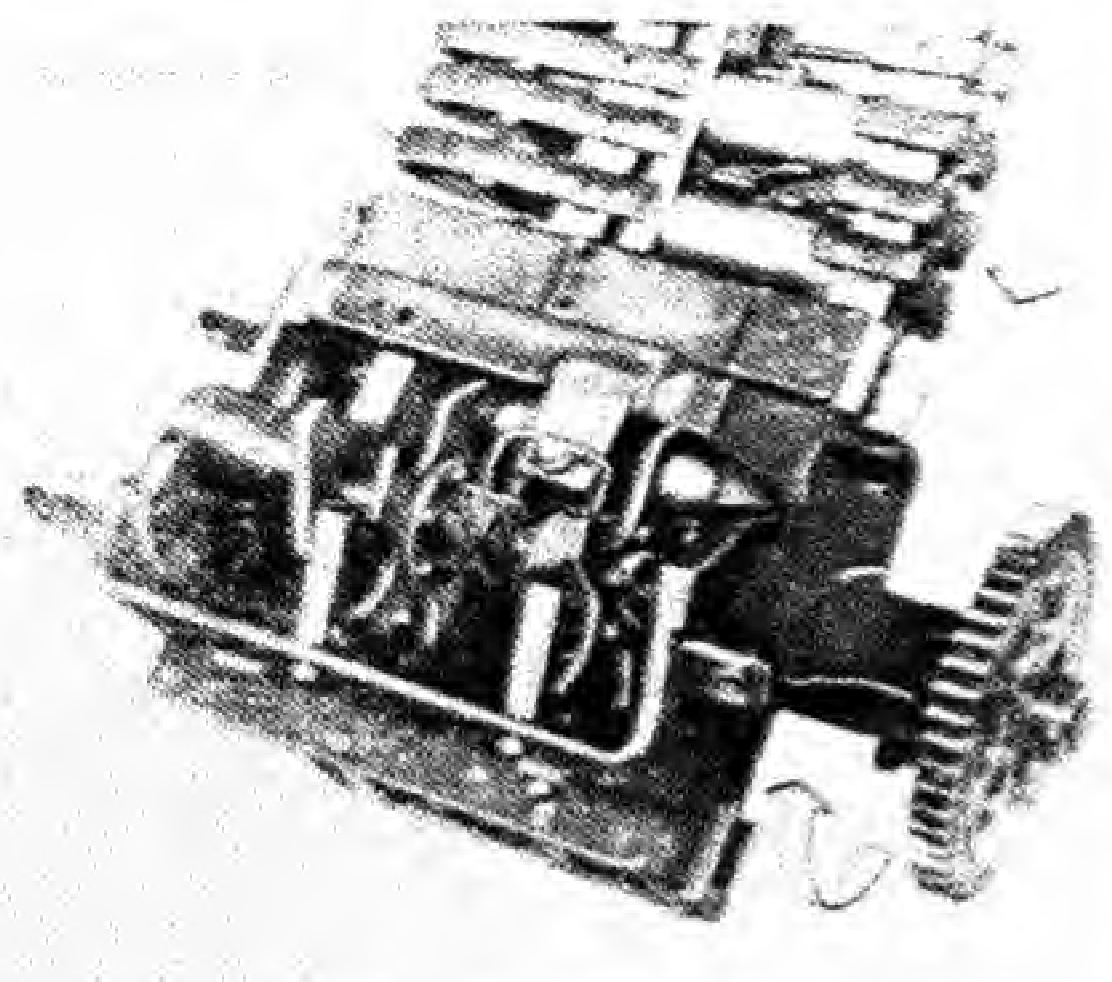
Feeder. The feeder is attached to the gun housing by two quick disconnect pins. The feeder gear engages the rear rotor gear in an "in-timed" condition so that, as the rotor and the feeder rotates, cartridges are handed off from the feeder sprockets to the gun bolts in the rotor. This happens through a slot in the



T12 Feeder: View of Mouth



T12 Feeder: View



Feeder Loaded with Belted Ammunition

housing using guides on the housing and on the guide bar.

The feeder sprocket has five pockets, not six as in the rotor, to save space and weight. This produces a six to five ratio between the gears. This also allows the feeder to pass off ammo to the bolt, and to get the feeder sprocket tips out of the bolt's path at an accelerated rate. This pass-off-path of the ammo to the bolt is somewhat tangential to both the rotor and the feeder.

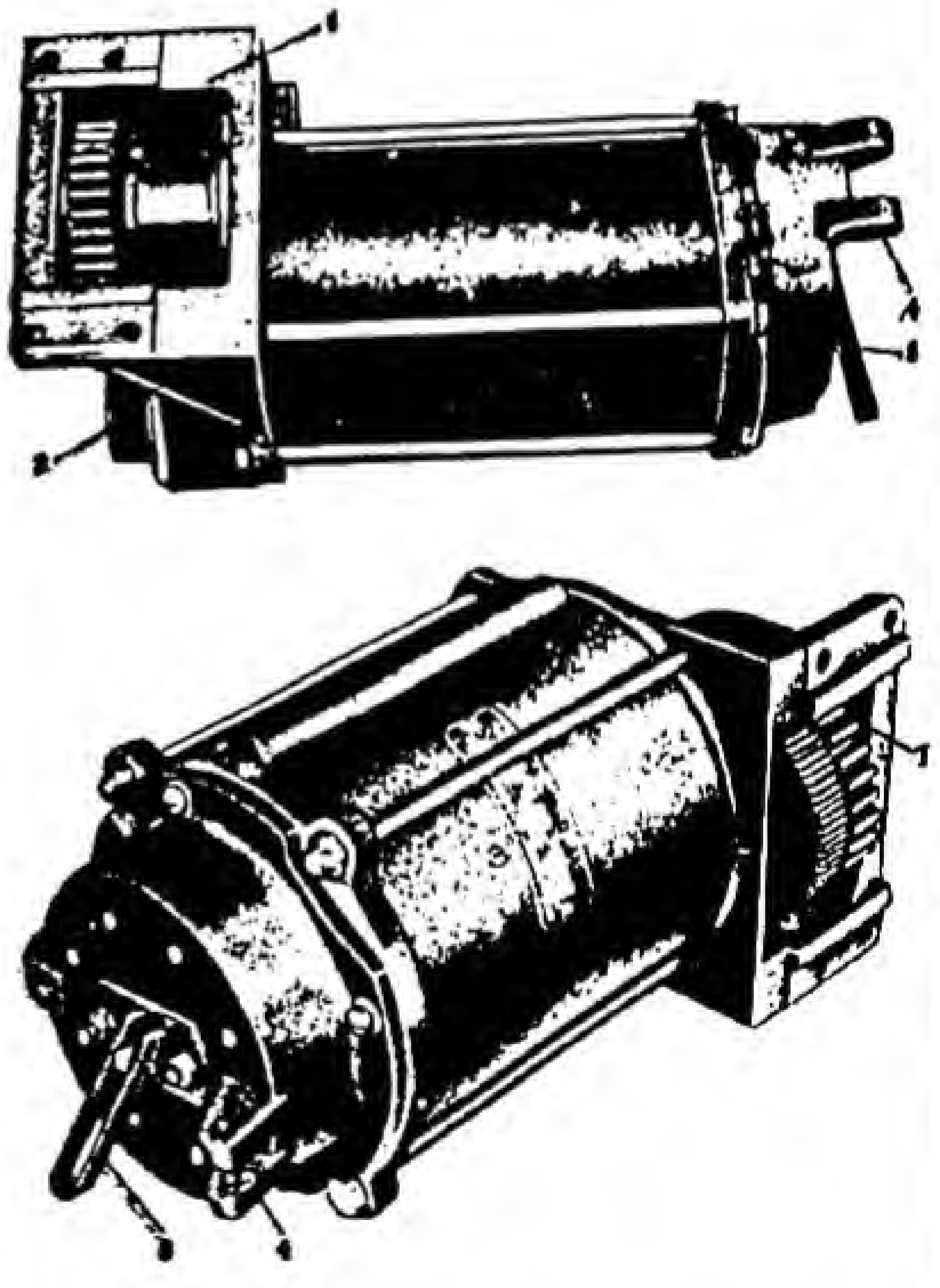
The feeder consists of a shafted sprocket located in the feeder housing that forms an ammo path from the entrance to the exit. At the entrance linked ammo is fed into the feeder via the attached ammo flexible chuting. The linked ammo proceeds through the circular path being pushed by the sprockets. Stripper guides force the links from the ammo in the sprockets. The links are de-coupled from each other and sent overboard. The ammo is delivered to the gun bolts by the sprockets.

A mechanical solenoid controlled clutch was added to some feeders for specific installations. The clutch is a knife blade actuated dog-lock device. It is located between the feeder gear and the feeder sprockets.

This clutch rotationally frees the feeder gear and locks the sprockets to the feeder housing to prevent ammo from entering the gun at the end of a burst while the gun coasts to zero speed to produce automatic gun clearing. While this happens, the feeder gear stays engaged with the rotor rear gear and turns freely with this gear. The feeder is considered to be in a "de-clutched" condition, while the solenoid is de-energized and the gun is clear.

At the start of a burst, the solenoid is energized along with the gun drive motor. Rotation of the rotor and hence feeder gear forces the traveling (solenoid controlled) circular knife ring to set up, in a timed condition, the unlocking of the sprockets from the housing, to locking the sprockets to the gear. This permits ammo to pass from the sprockets to the gun bolts while the gun accelerates to full firing speed, and gun firing commences.

Electric Gun Drives. There are two high performance electric gun drives for the Vulcan. The T45E1 drives the gear to fire at 6000 spm; and the T48 drives the gun to 4000 spm as required by specific installations.



M7 Electric Drive (Top) and T45E1 Electric Drive (Bottom)

The electric drives are bolted to the gun housing with their output gear mating with the rotor's forward gear. The drives have a brake to prevent rotation while the gun is at rest. A manual release is used for gun maintenance.

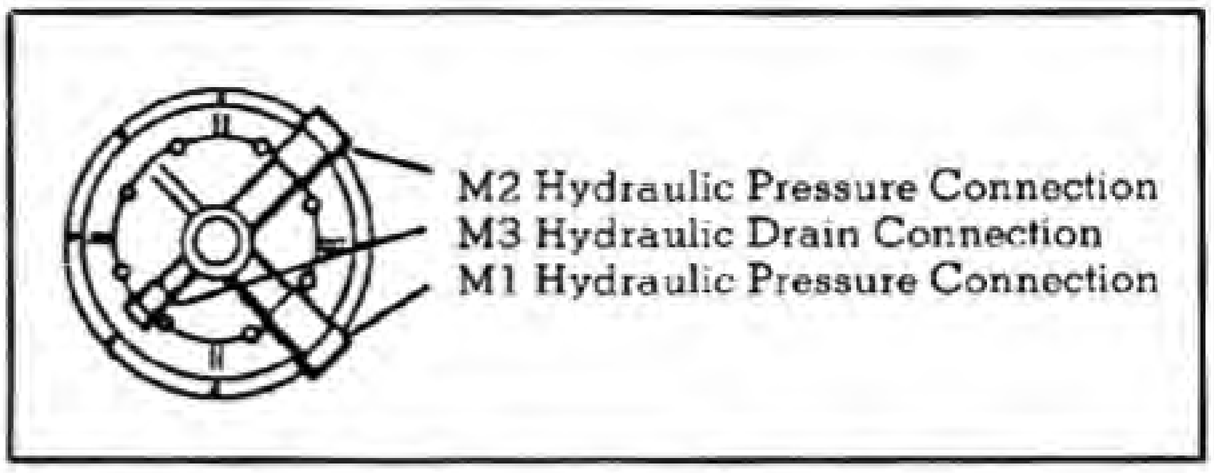
The T45E1 drive is a dual rotor, connected in parallel, electric motor that can be driven by either two non-parallel 20 Kva or one 40 Kva aircraft generator. It is a four-pole squirrel cage induction motor rated at 34 horsepower for intermittent duty. It operates from a 208 volt, 474 cps, three phase source. It drives the Vulcan gun to 6000 spm steady state rate in 0.4 spm in less than 0.4 seconds.

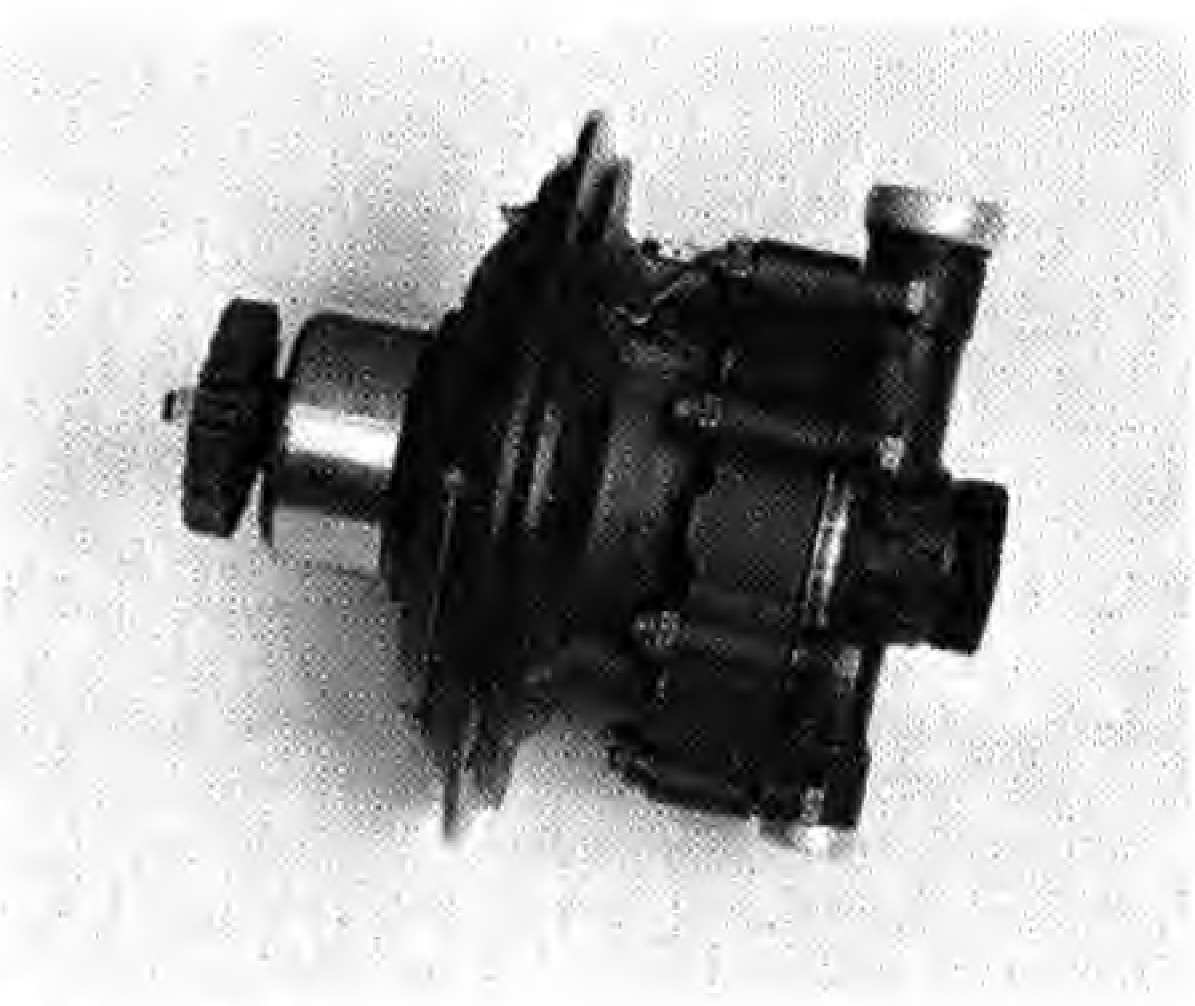
A DC motor is also available for 4000 spm firing. This is the T35E1 electric drive and operates from 28 VDC supplies.

Hydraulic Drives. Two hydraulic drives are available to power the Vulcan to 6000 spm or to 4000 spm. Both mount to the rear of the gun. They replace the gun's end plate and provide a bearing surface for the rotor's rear needle bearing. They also provide a central hole for the singular rear ball mount. A single Marlin clamp serves the drive to the housing.

The T31 has a ball hydraulic motor that is directly splined to the rear of the rotor. It operates from a 12 gpm 3000 psi supply and requires a pressure at the motor of 2400 psi for 4000 spm.

The T46E1 also has a ball hydraulic motor and operates from a supply of 25 gpm 3000 psi. It has a 2.1 to 1 gear train (planetary), and drives the Vulcan at 6000 spm.


M2 Hydraulic Pressure Connection
M3 Hydraulic Drain Connection
M1 Hydraulic Pressure Connection



Hydraulic T46

LINKLESS AMMUNITION FEED SYSTEMS

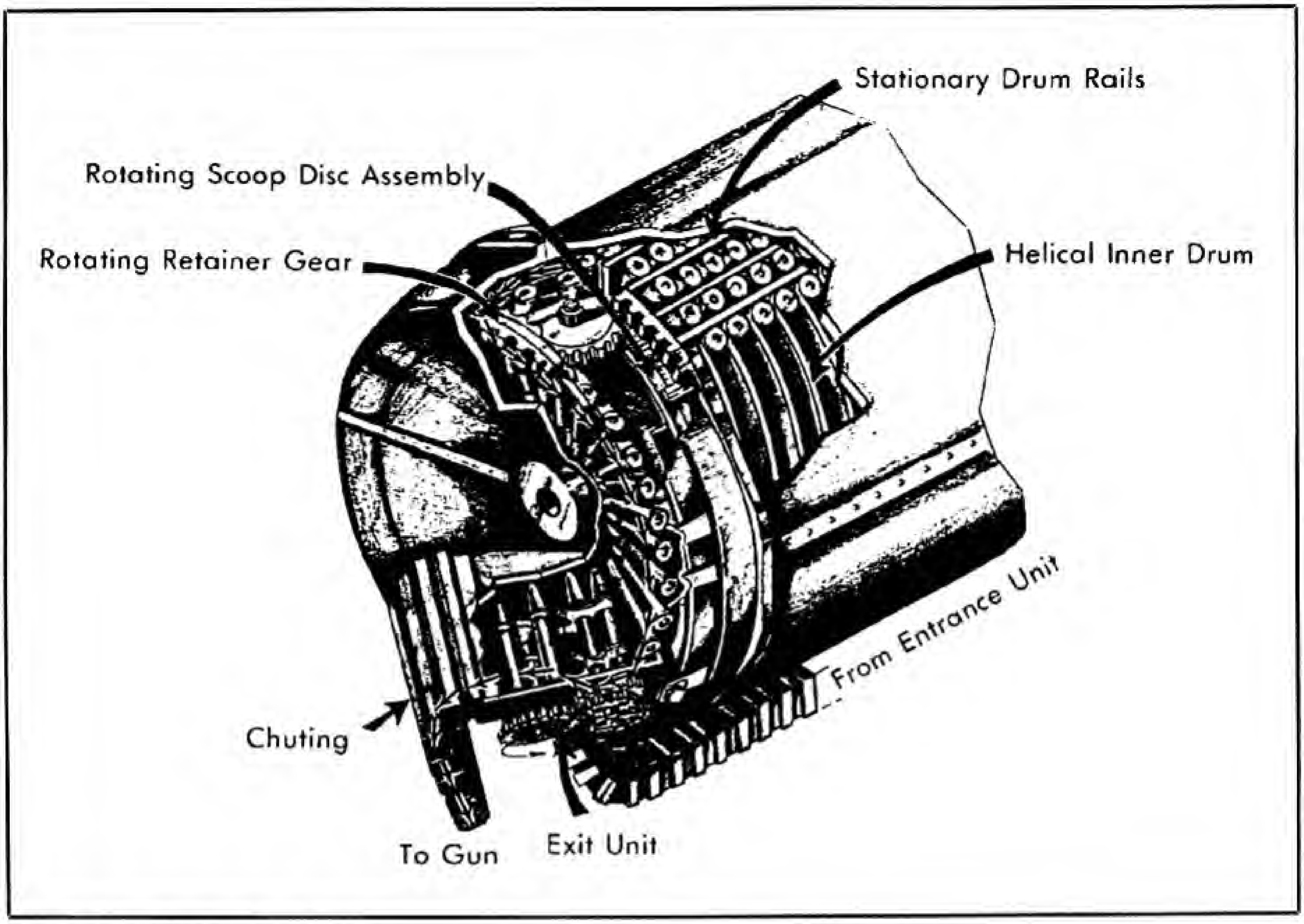
Problem and Solution

Since the early days in the development of the Vulcan guns, it was realized that the standard links and methods of storing and moving ammunition belts was limiting the successful operation of the guns. The time to accelerate the guns to full rate of 6000 spm was less than 0.4 second. The time to stop the gun from full rate was the same 0.4 second. These operations, together with the need for numerous short bursts in quick sequence with ammunition loads of up to 1000 rounds demanded the conception of new ammo storage and conveyance systems.

The Vulcan feeders pulled the ammo belts apart. Links would stretch, increasing their pitch and causing misfeeds at the entrance to the feeders. Links passing through the feeders at a rate of 100 per second would deform and break. Ammo belts going through fans, twists and bends created too much friction and would stall, snap and break. Conventional ammo box stacking methods of folds and loops caused extremely high accelerations and "S" bends of the free belts inside the boxes. These caused breaks and jams at the exits of the boxes.

Heavier and stronger links were tried and seemed to help, except they increased the stripping loads inside the feeders, causing more problems. Loading new rounds into these links became more difficult, sometimes damaging the ammo.

Soon, better link metallurgy and quality control, together with new ammo boosters and belt reservoirs and unique ammo storage containers were developed that allowed quite successful Vulcan firing up to rates



Double-Ended Linkless Feed System

of 4000 spm. However, full firing rates of 6000 spm were still marginal and very unreliable.

General Electric, Roy S. Sanford and Co., Nobles Engineering Co., and other industries with Springfield Armory and Eglin Air Force Base continued to work for new solutions. The conditions became critical in the middle 1950's when Vulcan gun installations were being made on the F104 and on the F105, the Air Forces new fighter aircraft.

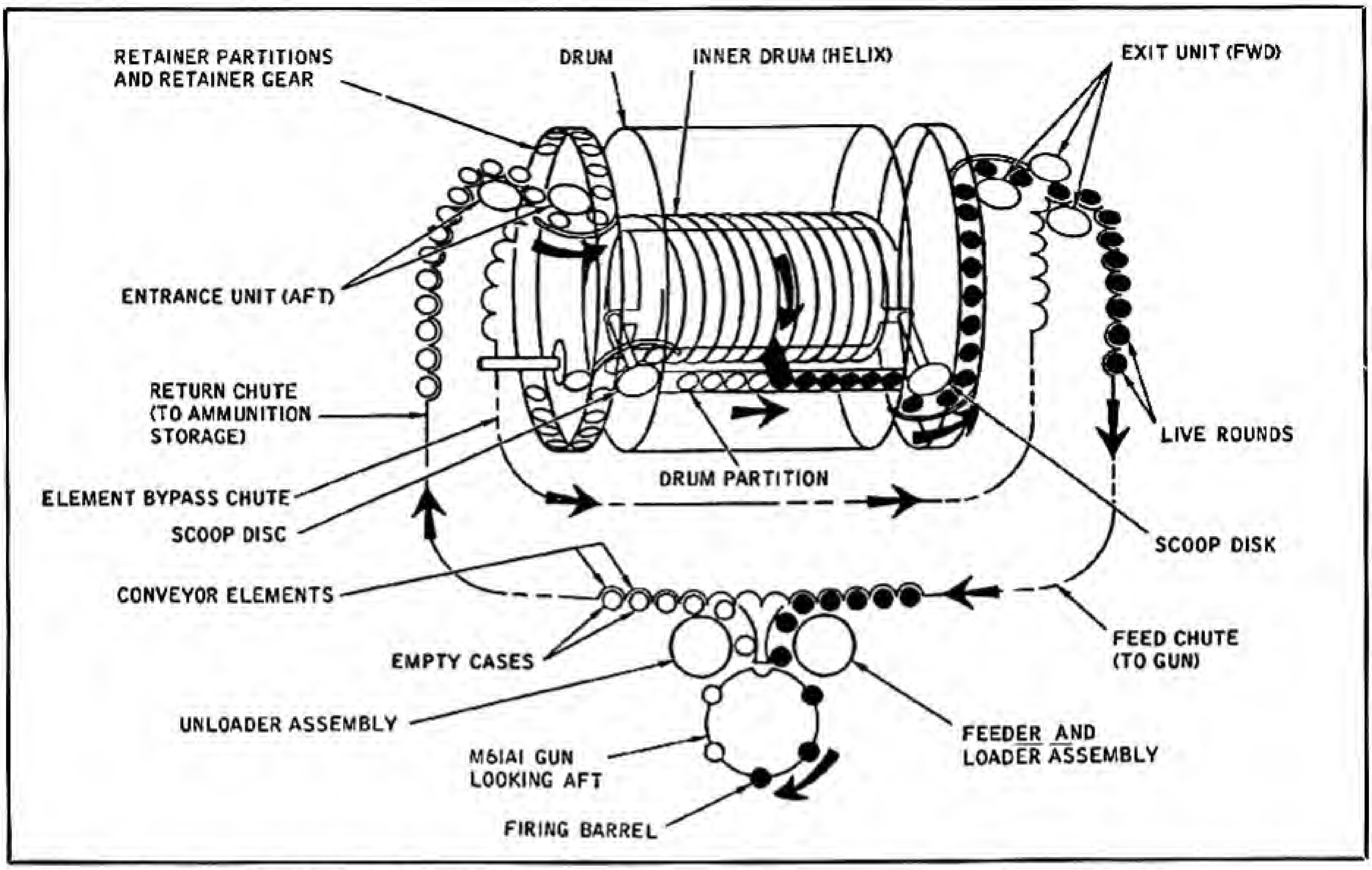
The F104 became limited to fire only up to 4000 spm. The F105 fired at 6000 spm but in order to do so, it had a dual feed system, with two ammo boxes and ammo belts. These fed into a dual feeder on the gun that cleverly mixed the two incoming ammo belts into one single stream of ammo into the gun for an acceptable but for a less than desirable and complicated feed system of questionable reliability with high maintainability.

During this time, the Roy S. Sanford and Co. conceived the Linkless Feed Drum. It was soon recognized as the missing solution for successful Vulcan firing at 6000 spm. This drum was then taken under development by General Electric through Springfield Armory and Eglin Air Force Base, and it was soon turned into an ammo feed and storage system for the F105D fighter for successful firing at 6000 spm for the first time.

Nobles Engineering and General Electric also worked on improving the ammo flexible feed chuting, the new links (now called conveyor elements) and the element flexible chuting. The new conveyor elements were stronger but no longer gripped the ammo. They merely encompassed each round forming a chain that moved the ammo through the flexible chuting.

Description and Operation

The Linkless Ammunition Feed System stores new ammunition without links in its drum, up to 1000 rounds or more. At the exit of the drum, the ammo is


RETAINER PARTITIONS AND RETAINER GEAR
DRUM
INNER DRUM (HELIX)
EXIT UNIT (FWD)
ENTRANCE UNIT (AFT)
RETURN CHUTE (TO AMMUNITION STORAGE)
ELEMENT BYPASS CHUTE
SCOOP DISC
DRUM PARTITION
LIVE ROUNDS
SCOOP DISK
CONVEYOR ELEMENTS
EMPTY CASES
FEED CHUTE (TO GUN)
UNLOADER ASSEMBLY
FEEDER AND LOADER ASSEMBLY
M61A1 GUN LOOKING AFT
FIRING BARREL

Double End Linkless Feed System Schematic

placed in a conveyor one at a time and is transported to the gun. At the gun, the transfer unit takes the ammo from the conveyor and delivers it to the gun bolt. The ammo is fired (or is a dud), and at gun ejection the empty case (or dud) is given back to the transfer unit. As the empty conveyor is passing through the transfer unit, the ammo is being fired so that the empty case is placed in the conveyor just before it leaves the transfer unit. The empty case is then transported back to the drum's entrance which is at the opposite end of the drum from which new ammo exits. The empty case is then moved into the drum for storage. While the gun is firing, all ammo and empty cases are moving from the drum's entrance to the drum's exit. The conveyor that delivered the empty case to the drum, continues to move, also, toward the drum's exit. Here it picks up a new round of ammo to repeat the cycle.

The drum then stores both new ammo and empty cases. It is full of new ammo after it has been loaded and is full of empty cases when it is fired out.

Every round of ammunition has a space of its own while in the drum or in transit or in the gun and transfers from one unit to the other during firing or loading. No matter where the specific round is located in any unit or being transferred, it is fully controlled and guided and never permitted to be free in space. It is because of this feature of perfect continued control of the ammo that full gun rate of 6000 spm and over is successfully achieved with most high reliability and least maintenance.

The Linkless Feed System is loaded with new ammo (or down loaded) by attaching a loading unit to the transfer unit. As the system is cycled, new linked ammo enters the loading unit from an outside storage container. The loading unit then takes a spent case from the transfer unit and gives back a new round into the same space from which the empty case came from. Also, the empty case enters the same link from which a new round first came from. The belt of empties then exits the loading unit and returns to an outside storage.

This linkless feed system is called a "double-ended" system because it's important since some aircraft installations cannot eject the empties case overboard. However, when empties can be dumped overboard, there is no need to return them to the drum saving expense and complexity. A linkless feed system such as this is called a "single-ended" system.

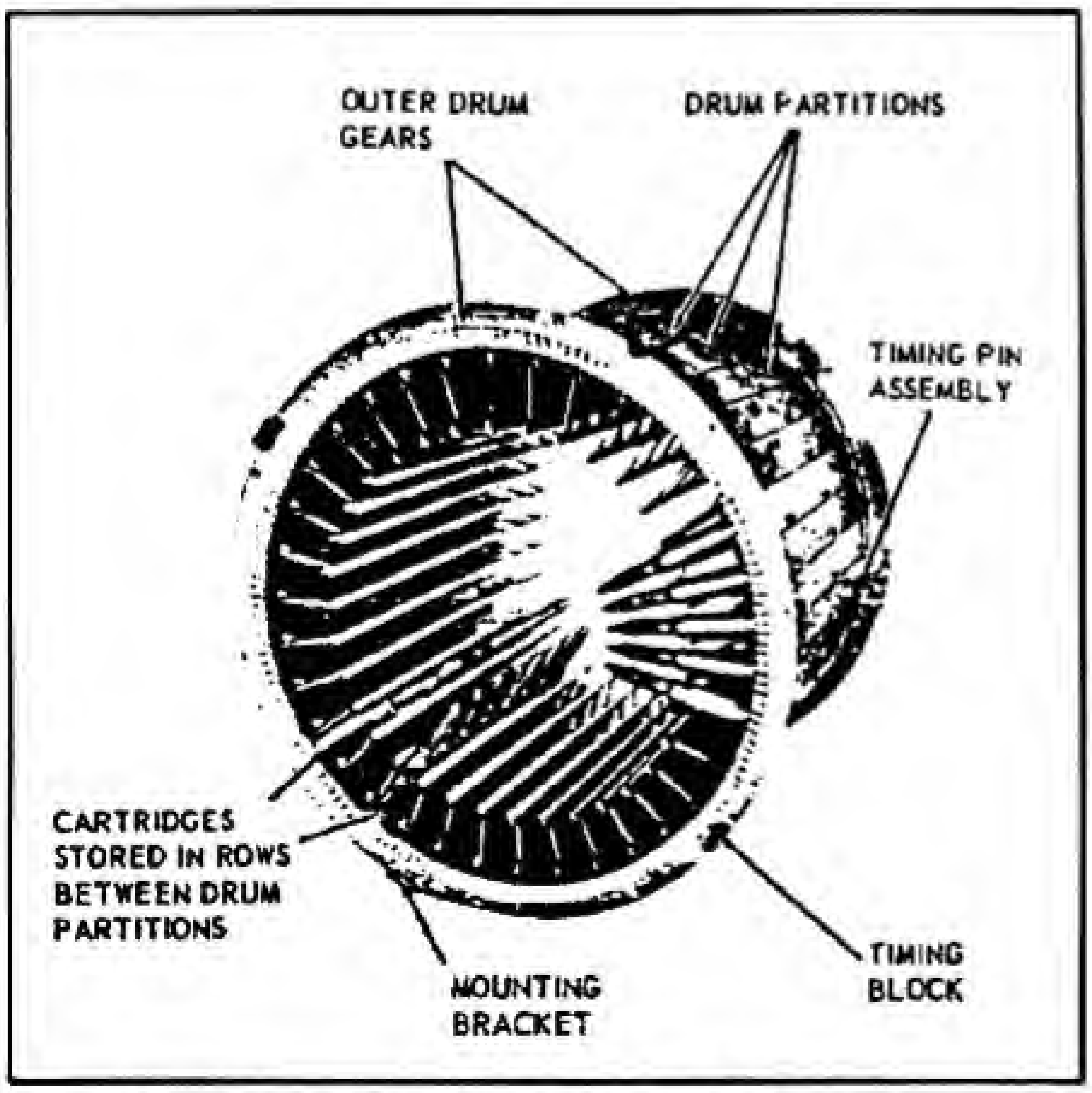
In the "single-ended" system, new ammo is conveyed from the drum to the gun as in the "double-ended" system. The gun after firing will eject the empties overboard by itself, or an ejection unit can be placed on the gun to increase ejection velocity. The conveyors then leave the transfer unit and go back empty to the drum to get another new round and repeat the transit cycle.

Components and Function

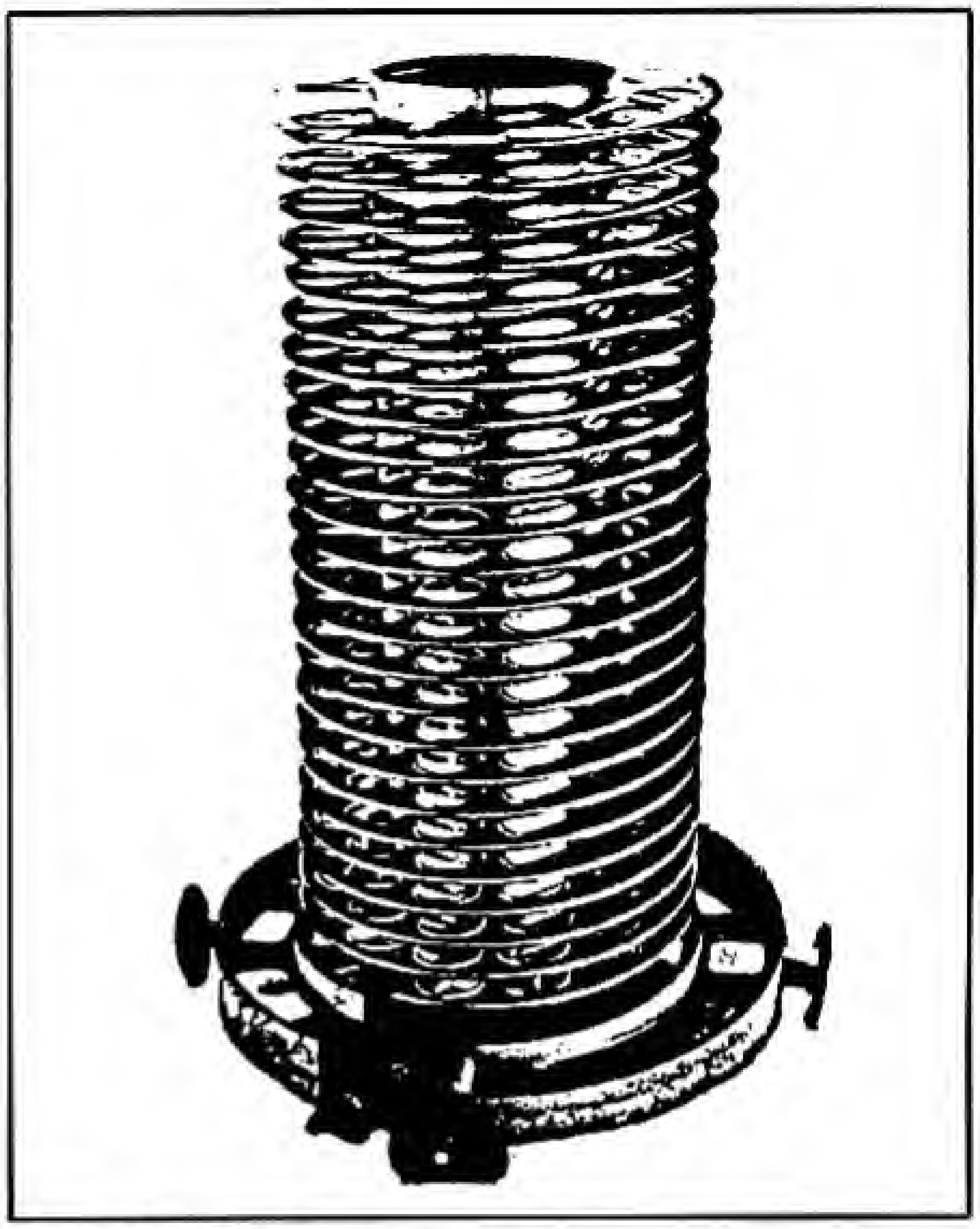
Drum. The drum is the major component of the linkless feed system. It can be described as having a storage area and an exit area. If it is "double-ended" it also has an entrance area which is exactly the same as the exit area except turns in the opposite direction.

The storage area contains by far most of the ammo in the system. It is a drum with all the ammo being radial. The ammo butts are against the inside of the drum's skin. The projectiles point toward the drum's centerline and are partially retained from moving inwards because of the inner helix.

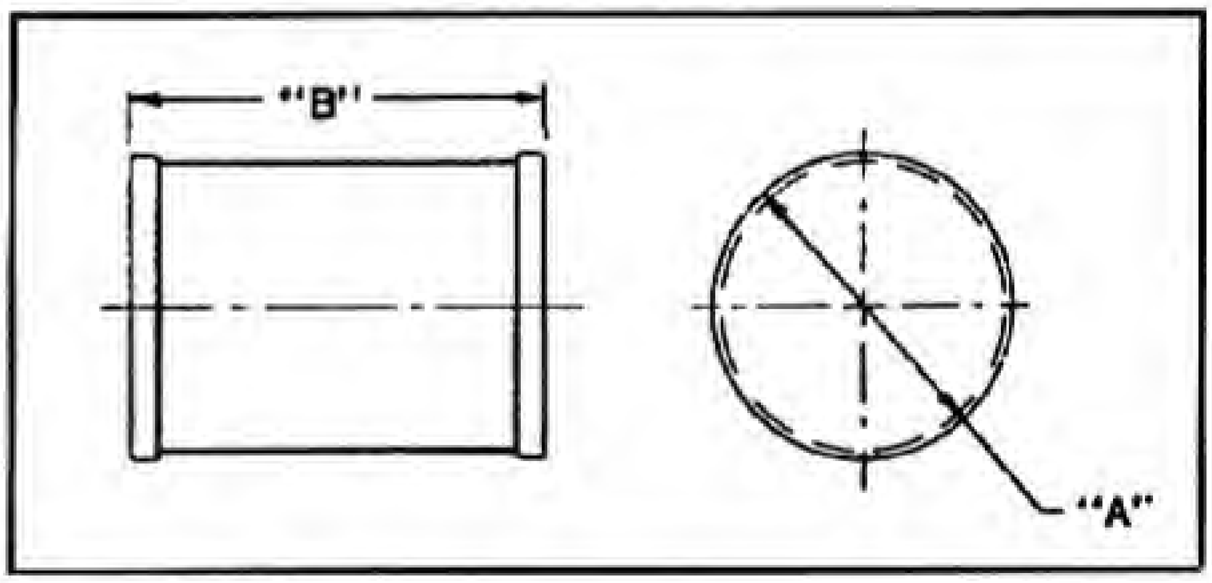
The drum does not move. The ammo inside can move only longitudinally along stationary partitions fastened to the drum. The ammo moves due to the inner helix which rotates but does not move longitudinally. So, all the ammo (or empties or duds)



Outer Drum Showing Position of Stored Rounds



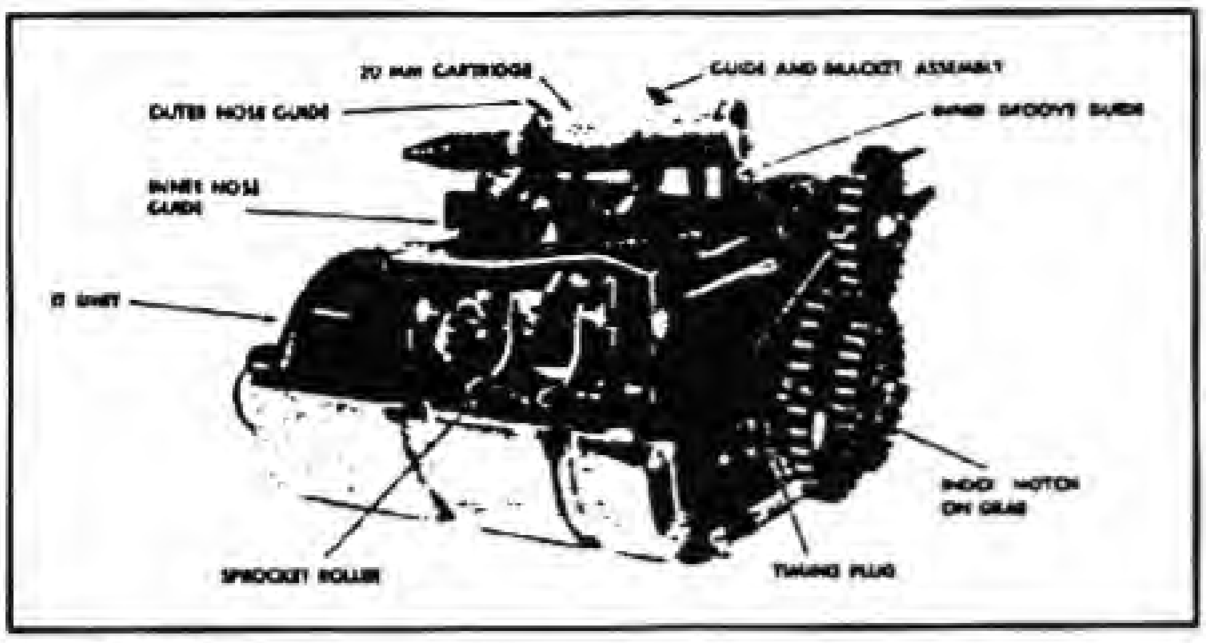
Helical Inner Drum



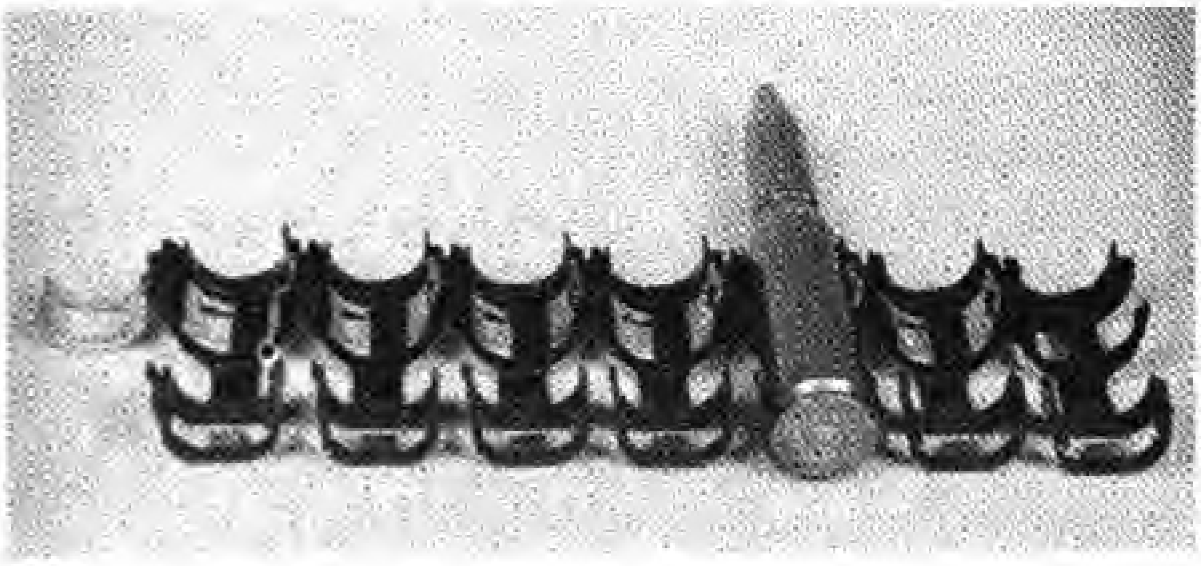
Drum Outline

CHARACTERISTICS OF 1000 ROUND CAPACITY DRUM

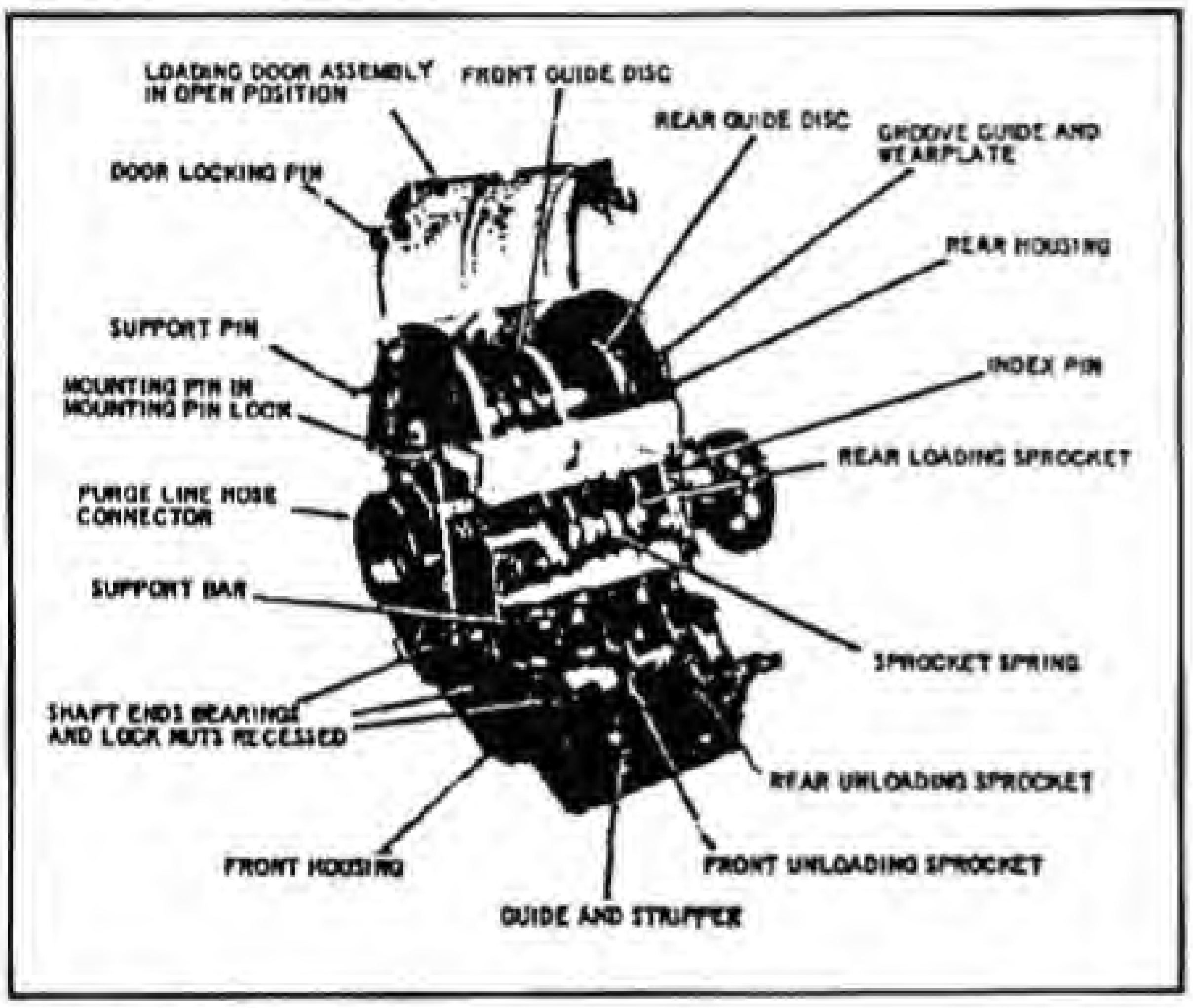
SYSTEM	"A" DIA.	"B" LENGTH	WEIGHT EMPTY	DRUM SPACES	LENGTH INCREASE PER 100 ROUNDS
DOUBLE END	22 IN.	48.50 IN.	280 LBS	32	3.90 IN.
SINGLE END		45.75 IN.	250 LBS		
DOUBLE END	26 IN.	35.40 IN.	270 LBS	46	2.70 IN.
SINGLE END		32.40 IN.	240 LBS		


20 MM CARTRIDGE
GUIDE AND BRACKET ASSEMBLY
OUTER HOSE GUIDE
INNER GROOVE GUIDE
INNER HOSE GUIDE
IT UNIT
INDEX NOTCH ON GEAR
SPROCKET ROLLER
TIMING PLUG

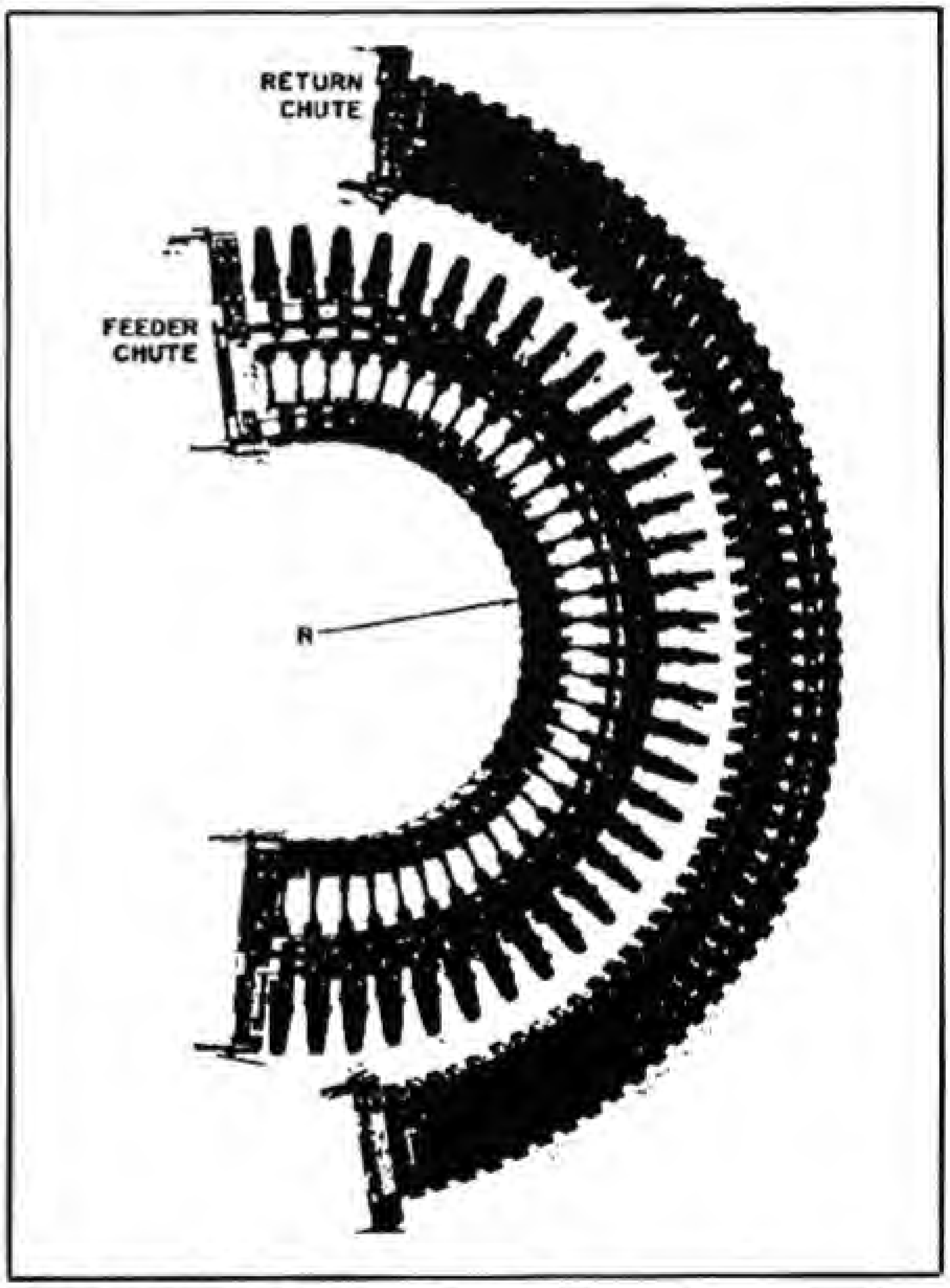
Exit Unit



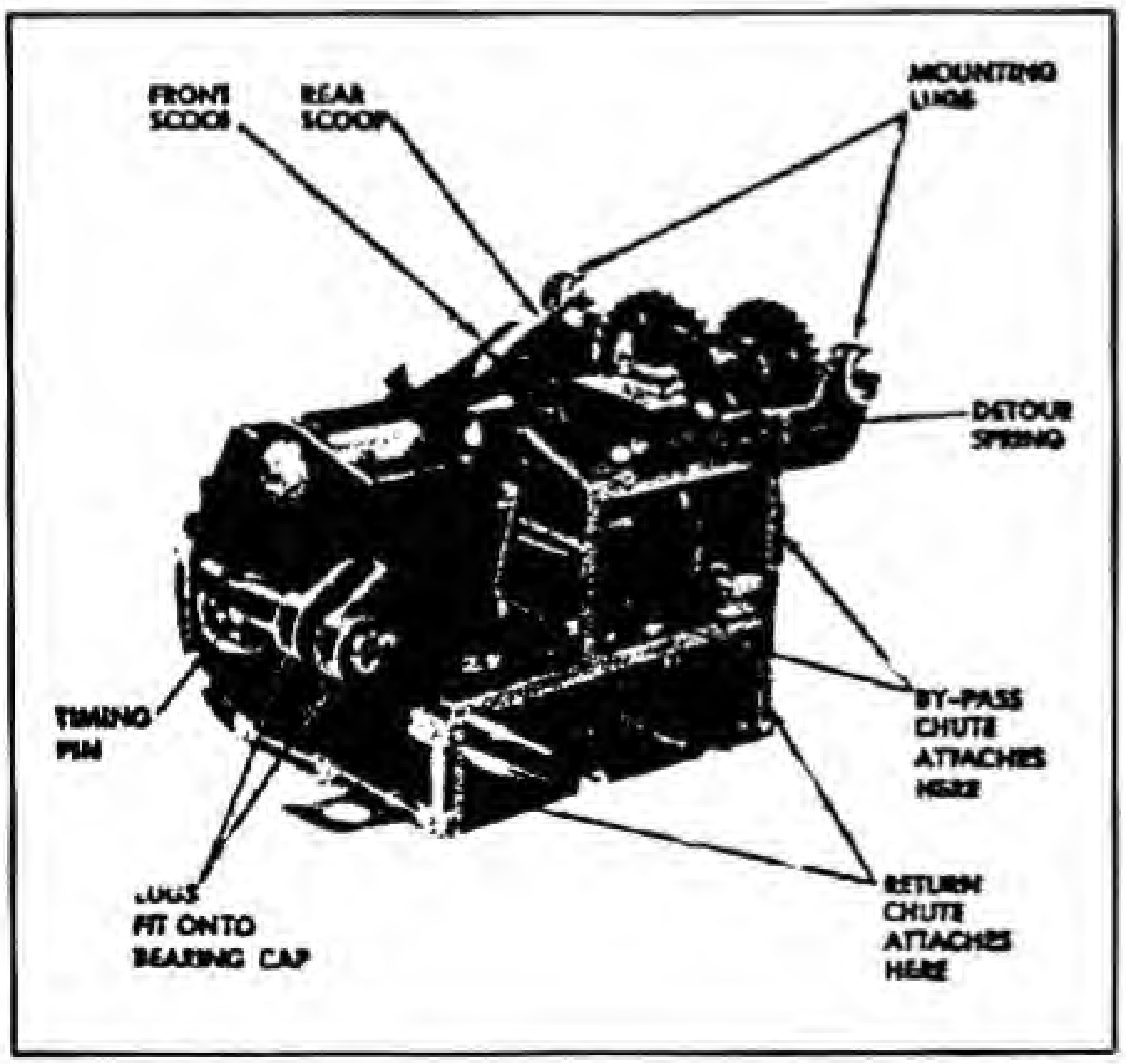
Conveyor Elements


LOADING DOOR ASSEMBLY IN OPEN POSITION
FRONT GUIDE DISC
REAR GUIDE DISC
GROOVE GUIDE AND WEARPLATE
DOOR LOCKING PIN
REAR HOUSING
SUPPORT PIN
INDEX PIN
MOUNTING PIN IN MOUNTING PIN LOCK
REAR LOADING SPROCKET
PURGE LINE HOSE CONNECTOR
SUPPORT BAR
SPROCKET SPRING
SHAFT ENDS BEARINGS AND LOCK NUTS RECESSED
REAR UNLOADING SPROCKET
FRONT HOUSING
FRONT UNLOADING SPROCKET
GUIDE AND STRIPPER

Transfer Unit

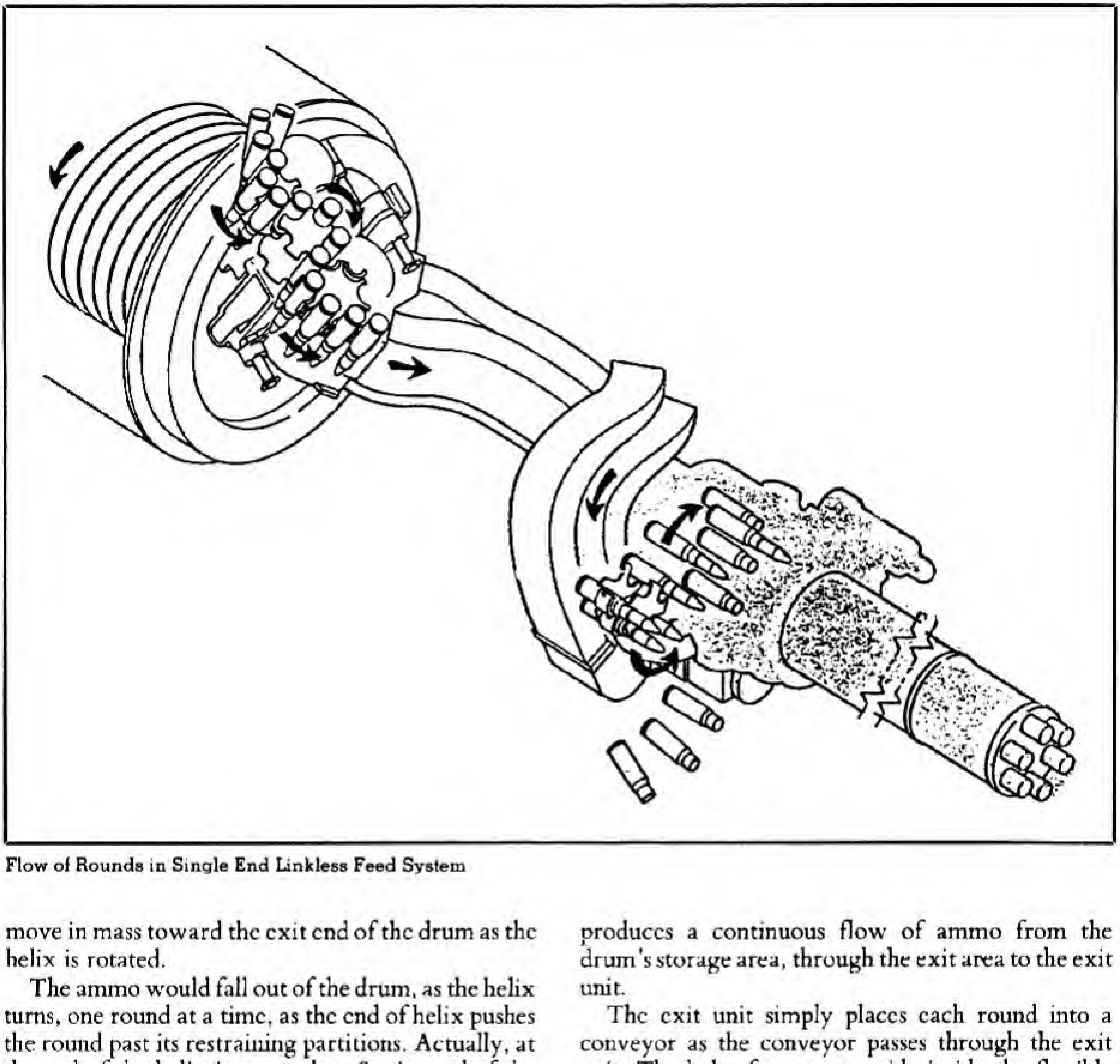

RETURN CHUTE
FEEDER CHUTE
R

Feed Chuting and Element Return Chuting


FRONT SCOOP
REAR SCOOP
MOUNTING LUGS
DETOUR SPRING
TIMING PIN
BY-PASS CHUTE ATTACHES HERE
LUGS FIT ONTO BEARING CAP
RETURN CHUTE ATTACHES HERE

Entrance Unit

	Feed Chute	Return Chute
Fold, R	2½"	2½"
Butt Fan, R	7¼"	10"
Nose Fan, R	5¼"	10"
90° Twist	24"	24"



Flow of Rounds in Single End Linkless Feed System

move in mass toward the exit end of the drum as the helix is rotated.

The ammo would fall out of the drum, as the helix turns, one round at a time, as the end of helix pushes the round past its restraining partitions. Actually, at the end of the helix is a sprocket. So, instead of the round falling it enters into the sprocket. In fact, the helix is a double helix and there are two sprockets, each catching a round as the end of the helix(s) passes each partition. The sprockets are 180° from each other.

The end of the drum has a cover inside of which is a ring of retainers which are geared to the helix. The retainers take the rounds from the sprockets and move the rounds to the fixed exit port on the cover. The drum exit unit is located outside this port, and has a sprocket that reaches into the port to pick up all the rounds, one at a time, from the retainers. This produces a continuous flow of ammo from the drum's storage area, through the exit area to the exit unit.

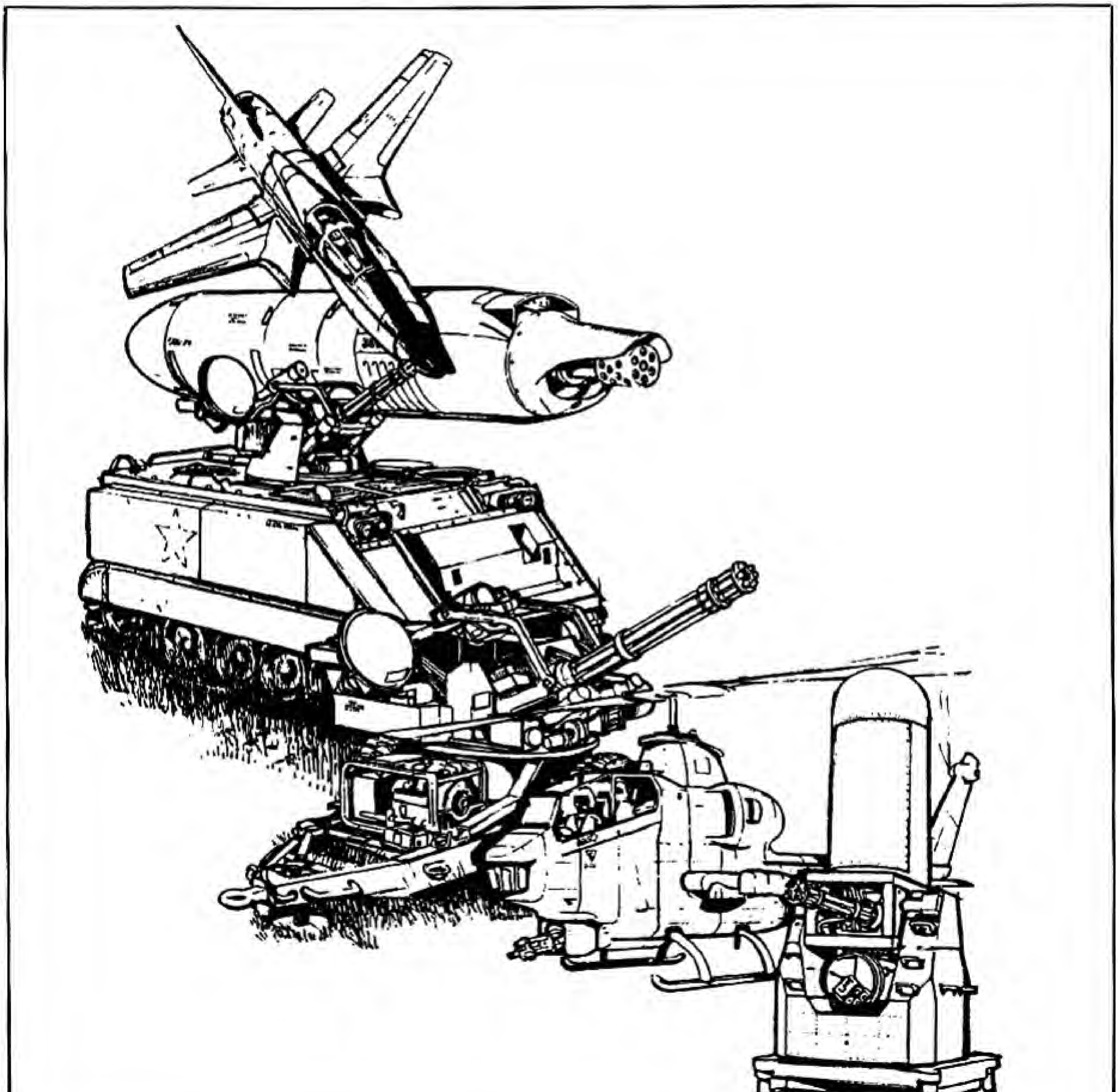
The exit unit simply places each round into a conveyor as the conveyor passes through the exit unit. The belt of conveyors ride inside the flexible chuting to the transfer unit and to the gun.

If the system is "double-ended" the conveyor will bring the spent cases back to the entrance side of the drum where the entrance unit will place them into the drum in a reverse manner from which the new ammo left the exit end of the drum. The conveyors will proceed to the exit unit for a new round and repeat the cycle.

If the system is "single-ended" the spent cases or duds are ejected overboard from the gun. The empty conveyors will go back to the exit unit for a new round and repeat the cycle of exit unit to gun to exit unit, etc.

When loading a "single-ended" system the rotation of the system is reversed and the system runs backward for "back-loading."

The linkless ammunition feed system is used on Vulcan M61A1 20mm gun systems, on Minigun GAU-2/A 7.62mm gun systems and on the Avenger GAU-8/A 30mm gun system. The minigun also has two inventive variations, one for side-fire and the other for the AT-37 nose system. Linked rotary storage systems have been used on minigun programs, one called the MAME on the Emerson X111-28 turret (Cobras) and the other called the Universal Rotary Ammunition Storage System (GE experimental).



Vulcan Gun Applications

APPLICATIONS OF THE VULCAN M61A1 20mm GUN

The Vulcan became a fully operational gun armament system able to fire reliable sustained bursts at 6000 spm when it was united with the Linkless Feed System on the F105D, U.S. Air Force fighter.

This happened around 1960 when most of the bugs were worked out of the F105D installation.

The U.S. Military together with U.S. Industry acquired at that time the long sought after, modern day jet age, new weapon system that was first visualized back after World War II in 1946.

From 1960 the Vulcan gun system with its partner, the Linkless Feed System (and their variations), has armed every new fighter of the U.S. Air Force, plus the B52H, and the B-58 bombers. Also armed with U.S. Navy fighter aircraft. Gun pods were produced. U.S. Army Air Defense units were outfitted with Vulcan. Ships of the U.S. Navy were provided with missile and air defense gun systems. Many helicopters from all the services were armed.

Some gun systems of Vulcan original and the M61A1 itself are in production in 1986. New variations are in test, and in design, and still some are in conception. The Vulcans have already seen 26 years of successful field operation and are still the gun systems of today and of the future.

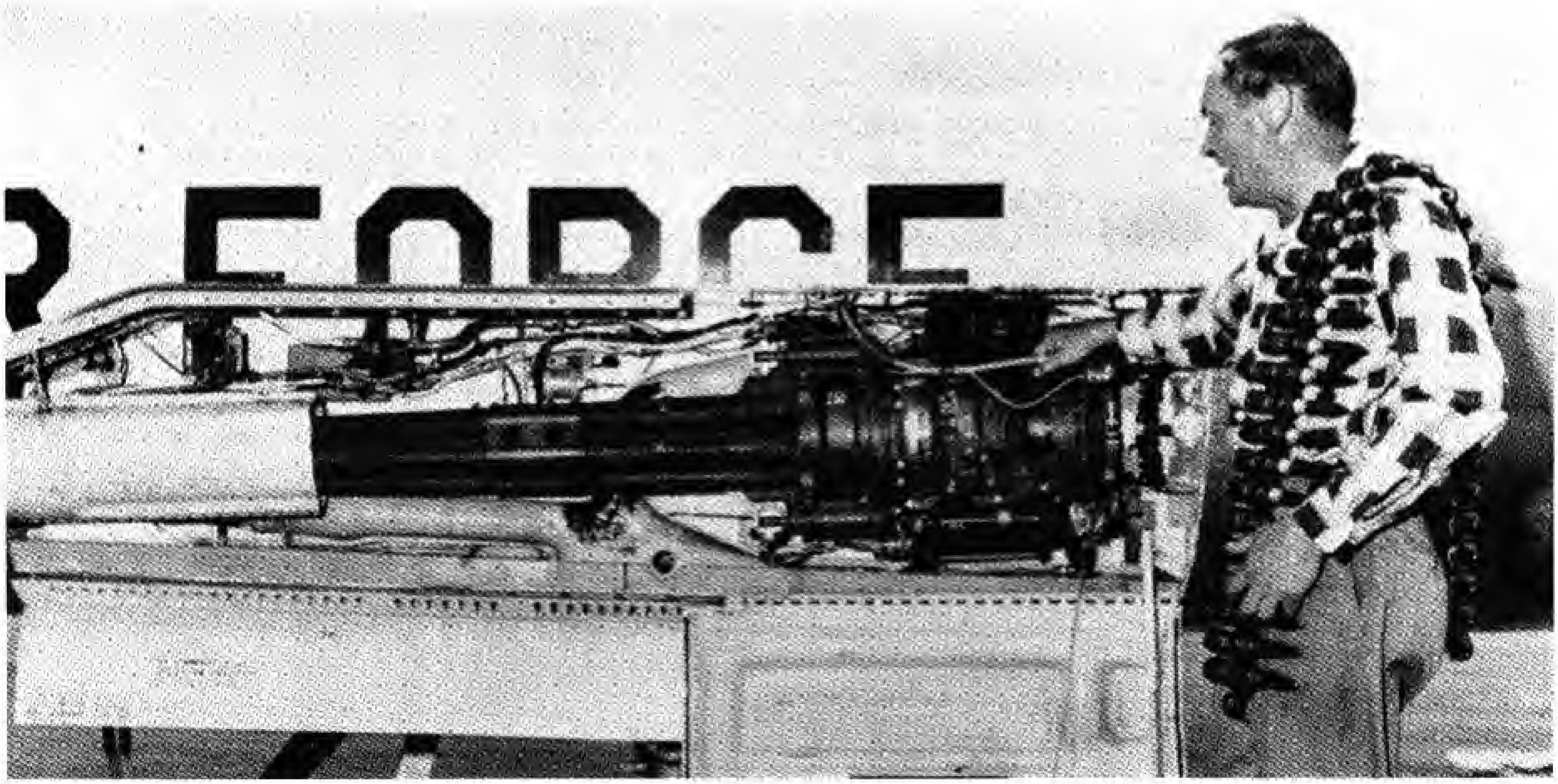
The following pages contain information on all Vulcan 20mm installations that obtained operational-production status.

1. Fighters:

F104. The first U.S. Air Force fighter aircraft to use the Vulcan gun was the F104. Installation and testing started in the mid 1950's using the M61 gun firing at 4000 spm.

One of the reasons for firing only 4000 spm was the undeveloped feed system at that time. Ammunition links, flexible ammunition chuting and storage boxes

F-104 Vulcan Armament System



F-104 Vulcan Armament System

were having difficulty supporting the gun at higher firing rates like 6000 spm. Ammo jams could take place inside the gun feeder mechanism, at the feeder entrance, in the flexible chuting and in the storage container, for the most part, because of ammo link failures. Broken or stretched links were most often the result or the cause of problems at the high firing rates. At 4000 spm, however, these problems were minimized or not existing, resulting in good firing reliabilities at this time of development.

The declutching gun feeder mechanism was used and cleared the gun of live ammunition at the end of each burst. This feeder stops the flow of ammo into the gun during coast down of the gun after the gun trigger is released. A solenoid clutch locks the sprocket to the fixed housing. When the gun is stopped it is completely free of new ammo, spent cases. On the next burst the solenoid clutch re-engages the sprocket to the gun and ammo again flows to the gun.

The F104 was widely used throughout the world by friends and allies of the U.S. Military.

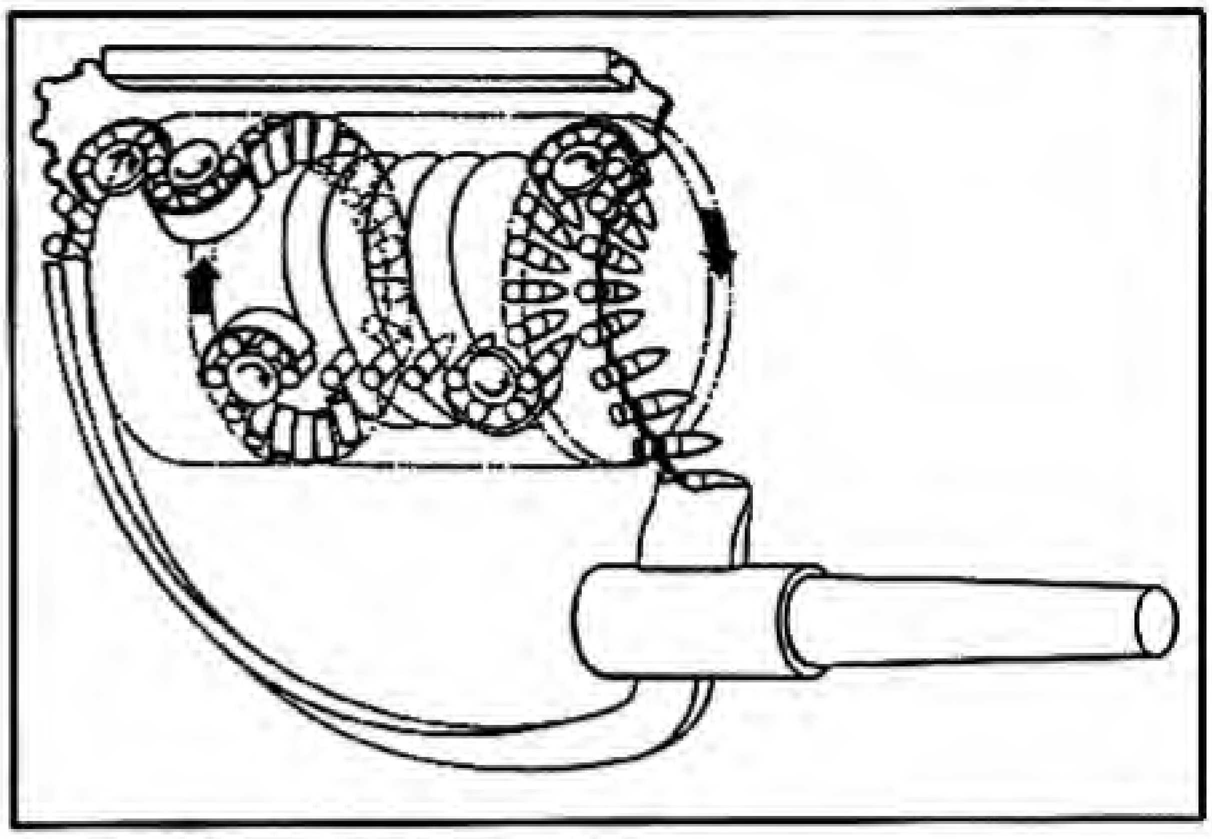
F105. The second U.S. fighter to use the M61 was the F105B. It experienced the same problems with the ammunition feed components of links, chuting and storage containers since its installations were in the time period of 1957. These ammo links, etc. were of marginal quality and design to accommodate the high firing rate of 6000 spm as was required for the F105.

The Republic Aircraft Co. conceived a unique design, however, to minimize their link difficulties by using a dual-feed-system. This system had two ammo cans and two flexible chutes of ammo running to the gun feeder.

At the feeder, both ammo belts met, each travelling at one half speed, and each experiencing lesser accelerations and steadier loads. The feeder mixed the two belts into a single stream of ammo which was fed into the gun, and, 6000 spm was achieved with good success. But, some difficulties still remained with the dual-feed-system. These included an extra complexity when loading the system with new ammo, with an overall increase in maintainability, also as when clearing malfunctions.

The Linkless Ammunition Feed System was developed at about this same time however, so that when it was ready it was installed in the F105D.

The F105D was the first to incorporate the M61A1 gun and a more powerful hydraulic drive, the T-46E1. The new components alleviated the F105B problems of ammo feed and of not quite reaching full 6000 spm firing rate. The new M61A1 gun required less torque and with the new hydraulic drive the F105D installation became the fighter gun system of the future. The F105D armament system went into production and achieved for the first time for the U.S. Air Force a jet age gun firing at a rate of 6000 spm with matching operationally proven reliabilities and maintainabilities.


F-105 Linkless Feed System

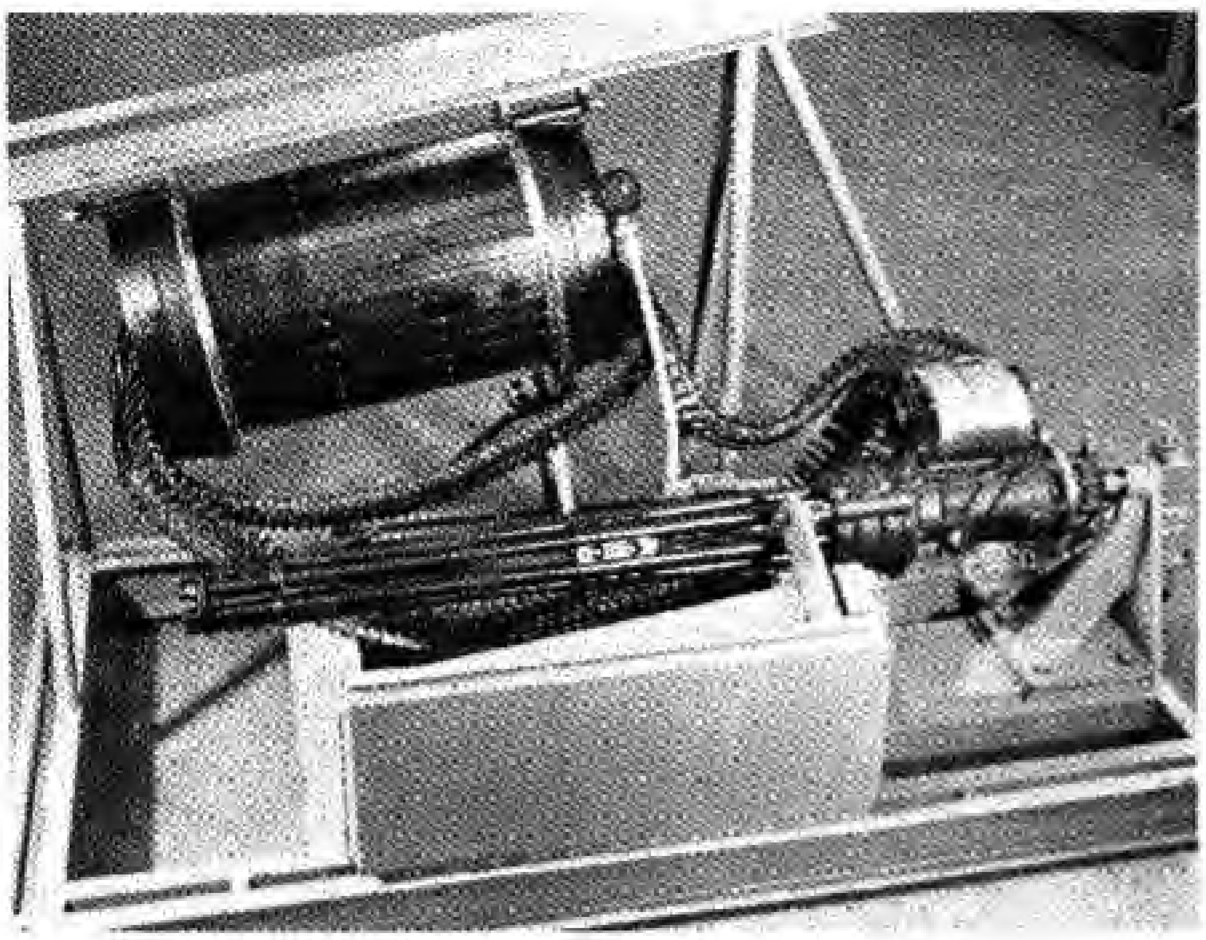
F4E. The U.S. Air Force F4E multi-role fighter is armed with the Vulcan M61A1 20mm gun and the Double-Ended Linkless Feed System. It fires at 6000 spm as mounted on the centerline in the nose of the aircraft. It became an operational in-production installation in late 1967.

The system components are mounted on a common structure called a pallet. The Linkless Feed Drum is mounted on brackets on top of the pallet. The gun's three mounts attach to a yoke at the two recoil adapters and a single aft support which are suspended below the pallet. The aft gun support incorporates bore sight adjustments for both azimuth and elevation when harmonizing to the aircraft.

This modular design simplifies the installation and removal of the complete armament system from the aircraft. Testing of the complete system can also be more easily accomplished prior to installation in the aircraft.

Ammunition is fed to the Vulcan M61A1 gun through the use of the Linkless Feed System. Spent cases and any unfired rounds are returned to the system's drum rather than be discarded overboard potentially damaging the aircraft and surrounding aircraft.

An endless conveyor belt of link like elements picks up live rounds from the exit end of the ammo

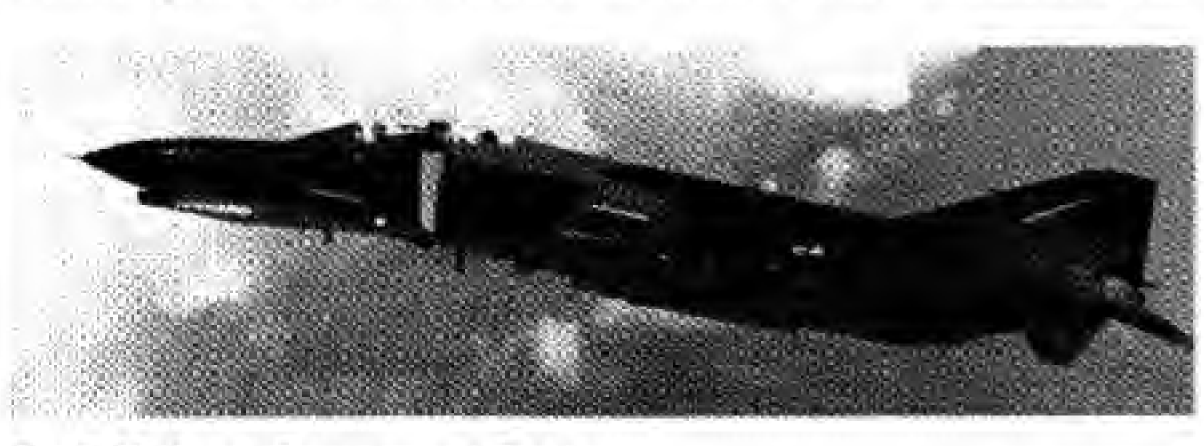


F-105 Vulcan Armament System

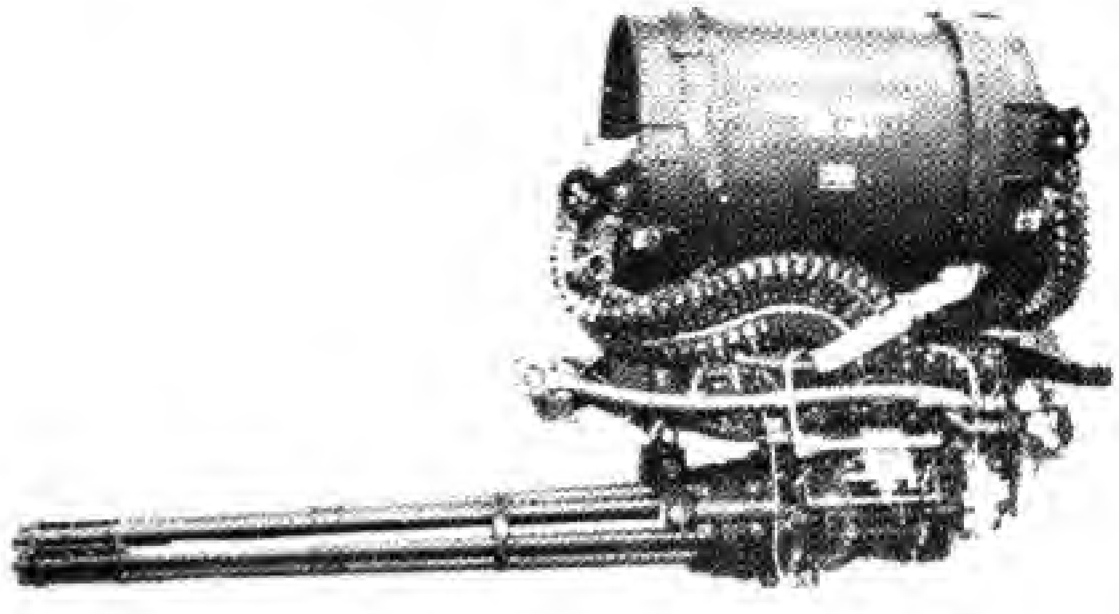
storage drum and transports them to the gun. After the rounds are fired in the gun, this same conveyor belt picks up the spent cases or duds and carries them to the entrance end of the drum. Here they are removed from the belt and placed into the drum. The conveyor belt then continues to the opposite end of the drum, the exit end, where it completes its cycle by picking up more live rounds.

The gun feeder assembly which transfers live rounds from the conveyor to the gun also incorporates a reload mechanism. Linked ammo fed into this mechanism from an outside source is stripped of links and loaded into the conveyor. Spent cases, duds and cleared rounds are taken from the conveyor and expelled overboard to an outside container. Loading is thus accomplished without the need of special support equipment.

Gun clearing is accomplished after each burst by the automatic gun clearing sector and assembly. This mechanism attaches to the rear of the gun housing, and places live ammo in a hold-back like condition during gun deceleration at the end of each burst.



F-4E Vulcan Armament System



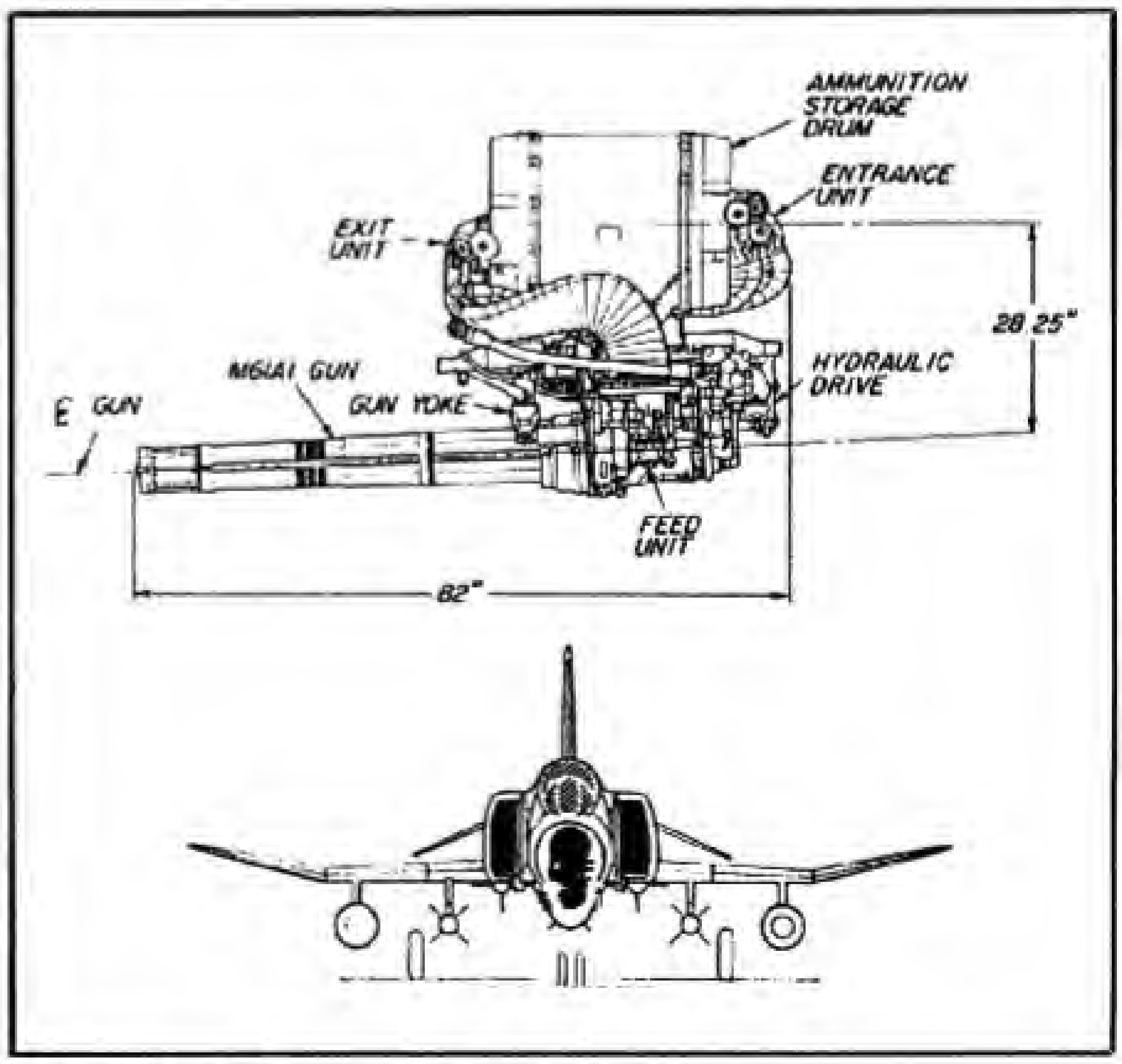
F-4E Vulcan Armament System

A7D and A7E. The U.S. Air Force A-7D and the U.S. Navy A-7E are armed with the Vulcan M61A1 20mm gun, and the double-ended Linkless Feed System. The gun is mounted in the port side of the forward fuselage for fixed forward firing. The Linkless Feed System is located behind the pilots station high in the fuselage. The ammo conveying belts connect the storage drum to the gun. These armament systems were first in production in 1968.

Live ammo is provided to the gun from the drum via the conveying belt. The ammo is fired and the spent cases are returned to the drum along with any duds or cleared rounds, also by the conveying belt.

The A-7D loader assembly loads the Linkless Feed System drum with M50 series 20mm ammo belted in M14 links from an outside container. The new rounds are loaded into the systems while discarding the links, the empty cases, duds and cleared rounds to the outside container.

The A-7E loader assembly loads 20mm ammo that



F-4E Vulcan Armament System

Characteristics

Gun	M61A1, 20mm
Length	82 in.
Height	47.8 in.
Ammunition Capacity	638 rds.
Drum Only	560 rds.
Total Weight:	
With Ammunition	979 lbs.
Less Ammunition	657 lbs.
Drum Weight	170 lbs.
Firing Rates	4000 & 6000 spm
Time To Rated Fire (maximum)	0.5 sec.
Muzzle Velocity	3500 ft/sec.
Maximum Recoil Travel	0.5 in.
Ammunition	M50 Series
Position of Firing Barrel	6 O'clock
Scheduled Maintenance	15,000 rds.
Barrel Life (per set)	18,000 rds.
Gun Life	145,000 rds.
Reliability	10,000 MRBF
Drive System	Hydraulic
Hydraulic Drive Requirements:	
@ 6000 spm	28.5 gpm at 1680 PMAX
@ 4000 spm	19.0 gpm at 1200 PMAX
Element Chuting Length:	
Feed	48 in.
Return	30 in.
Firing Rate Selection	Pilot Option
Rounds Limiter	For Training - Pre Set
Rounds Remaining Indicator	Cockpit Display

is contained in the Mk 7 Mod 0 (or XM26) link with protective radiation hazard tabs. The links, empty cases, duds and cleared rounds are discarded.

The A-7D and the A-7E Vulcan Armament Systems are identical except for the ammo loader assemblies.

The gun firing rate is 6000 spm with a pilot's option for 4000 spm. The gun is cleared after each burst by the automatic clearing sector assembly which places the gun bolts with live ammo in a hold-back like condition. The cleared live rounds are not fired but returned to the drum and later discarded.

The hydraulic power is applied at the gun to drive the system. The Linkless Feed drum is driven in time with the gun by a drive shaft that connects the drum to the gun.

The gun's muzzle is on the port side and behind the engine air scoop to keep gun gas out of the engine.

F-111A. The U.S. Air Force F-111A has the Vulcan M61A1 20mm gun contained in its belly location. The gun fires at 5000 spm. A single-ended linkless feed system holds up to 2000 rounds of 20mm M50 series ammunition. This system was first in production in 1967.

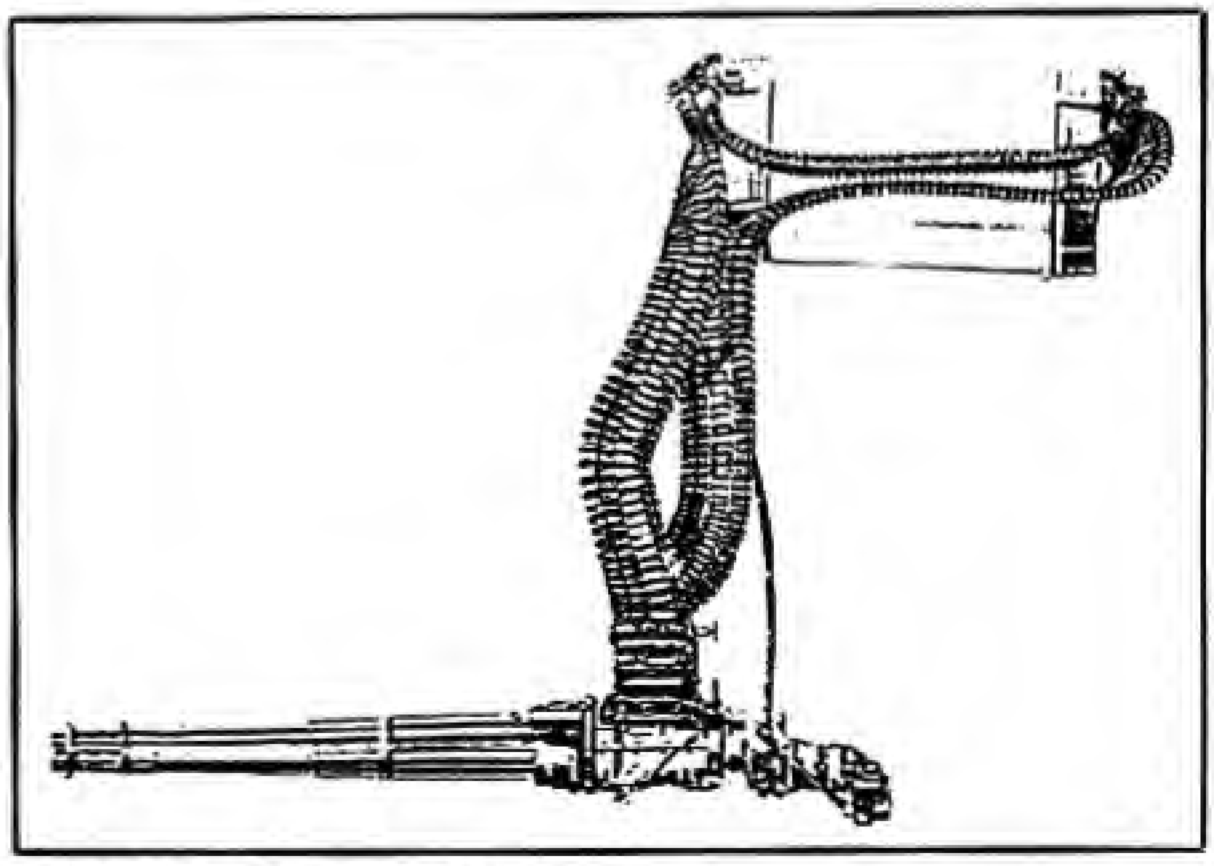
The single-ended drum provides ammo to the gun by the conveying belt. Empty cases, duds and cleared rounds are put into the same conveyors and moved to a separate storage bin above the gun.

A-7 Vulcan Armament System

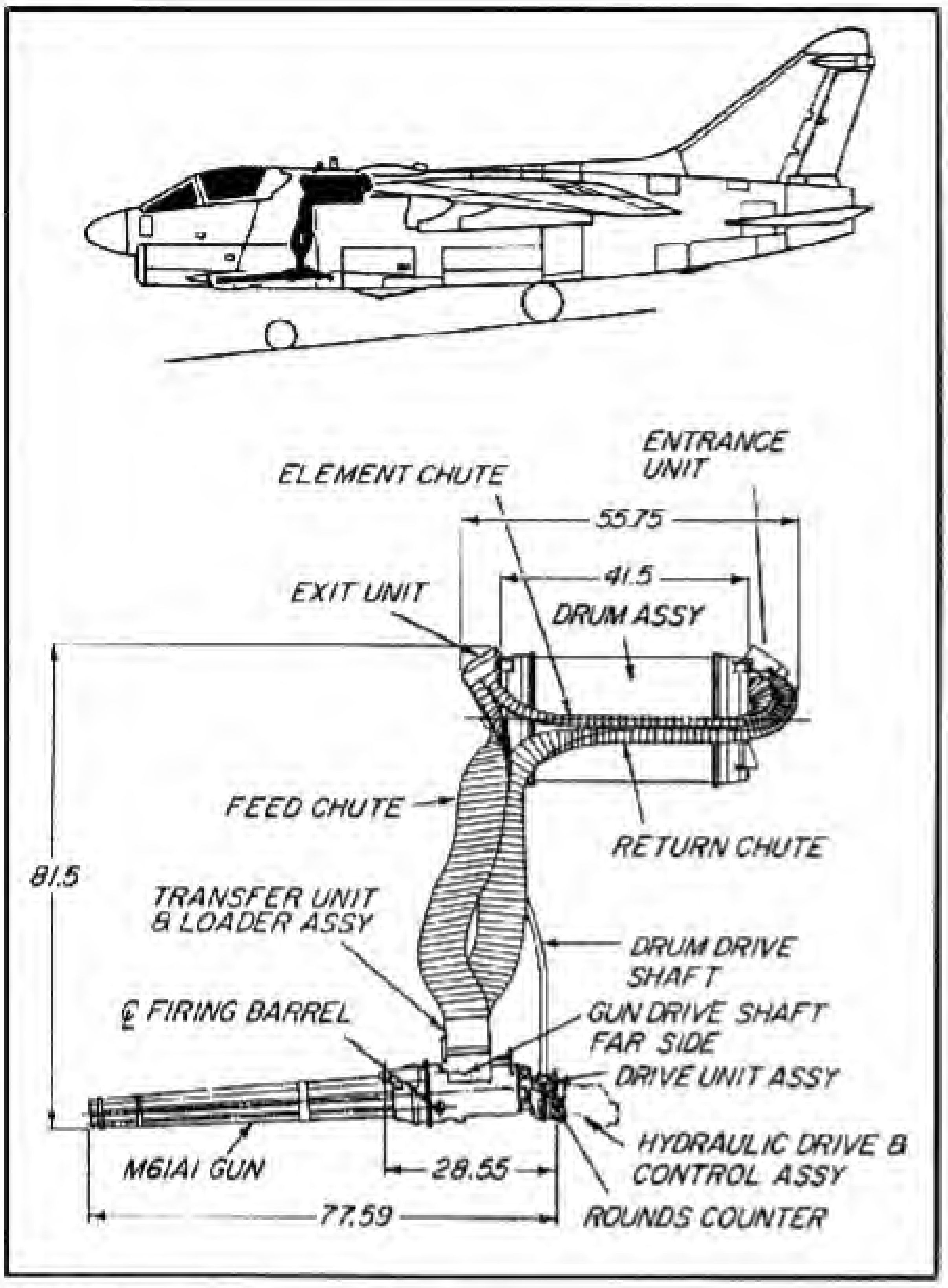
The drum is back-loaded with new ammo from the gun's feeder mechanism. The empties storage bin is separately downloaded.

Gun clearing takes place at the end of each burst placing all the gun bolts with live ammo into a hold-back condition.

F-106. The Vulcan M61A1 20mm Armament System was first installed in the U.S. Air Force F-106 aircraft in 1975.



A-7 Vulcan Armament System


ELEMENT CHUTE
ENTRANCE UNIT
55.75
41.5
DRUM ASSY
EXIT UNIT
FEED CHUTE
RETURN CHUTE
81.5
TRANSFER UNIT & LOADER ASSY
DRUM DRIVE SHAFT
℄ FIRING BARREL
GUN DRIVE SHAFT FAR SIDE
DRIVE UNIT ASSY
HYDRAULIC DRIVE & CONTROL ASSY
M61A1 GUN
28.55
77.59
ROUNDS COUNTER

A-7 Vulcan Armament System

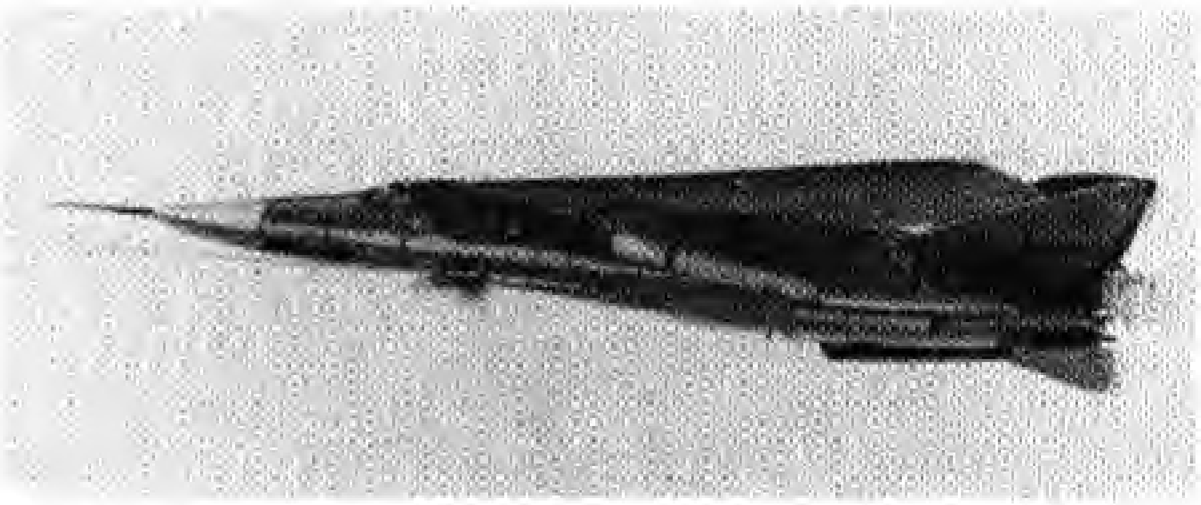
The components of the gun and the Double-Ended Linkless Feed System are mounted to a pallet in a compact arrangement which is mated with an enclosure to provide a self-contained module. This module can be readily installed and removed from the aircraft rocket bay as a unit. Where installing the module in the aircraft, only quick-disconnect type hydraulic and electrical connections need to be made. Similarly, once this armament system has been removed, the aircraft can accept the original missile system.

New ammo is conveyed to the gun from the drum. It is fired, and the empty cases, duds and cleared rounds are returned to the drum. New ammo is loaded at the gun's feeder location. Empties, duds and cleared rounds are discarded while loading.

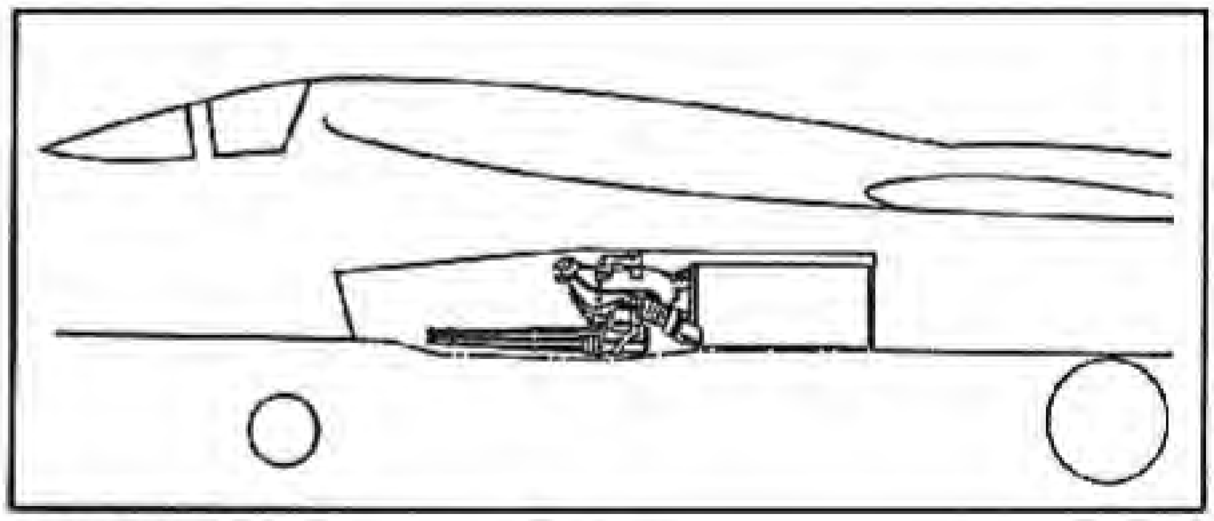
The firing rate is 4500 spm. Automatic gun clearing is provided after each burst. The total ammunition load is 650 rounds of M50 type 20mm.

F-14. The U.S. Navy's carrier based multi-mission F-14 fighter is armed with the Vulcan M61A1 20mm gun and Linkless Feed System. The gun is located low on the port side of the forward fuselage. The gun fires at 6000 spm with an option for 4000 spm.

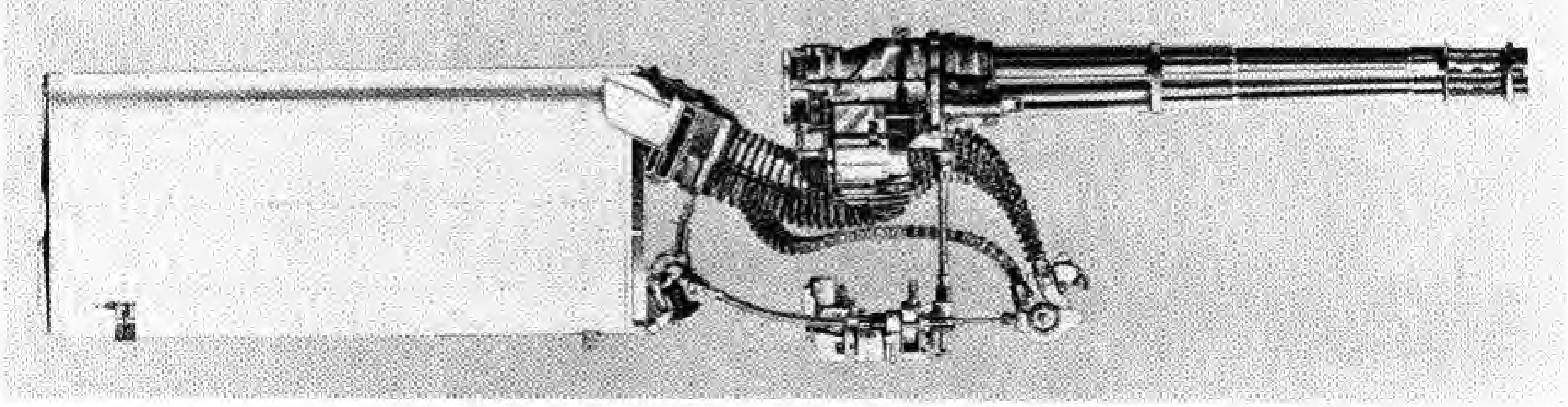
During the initial installation, emphasis was placed



F-111 Vulcan Armament System



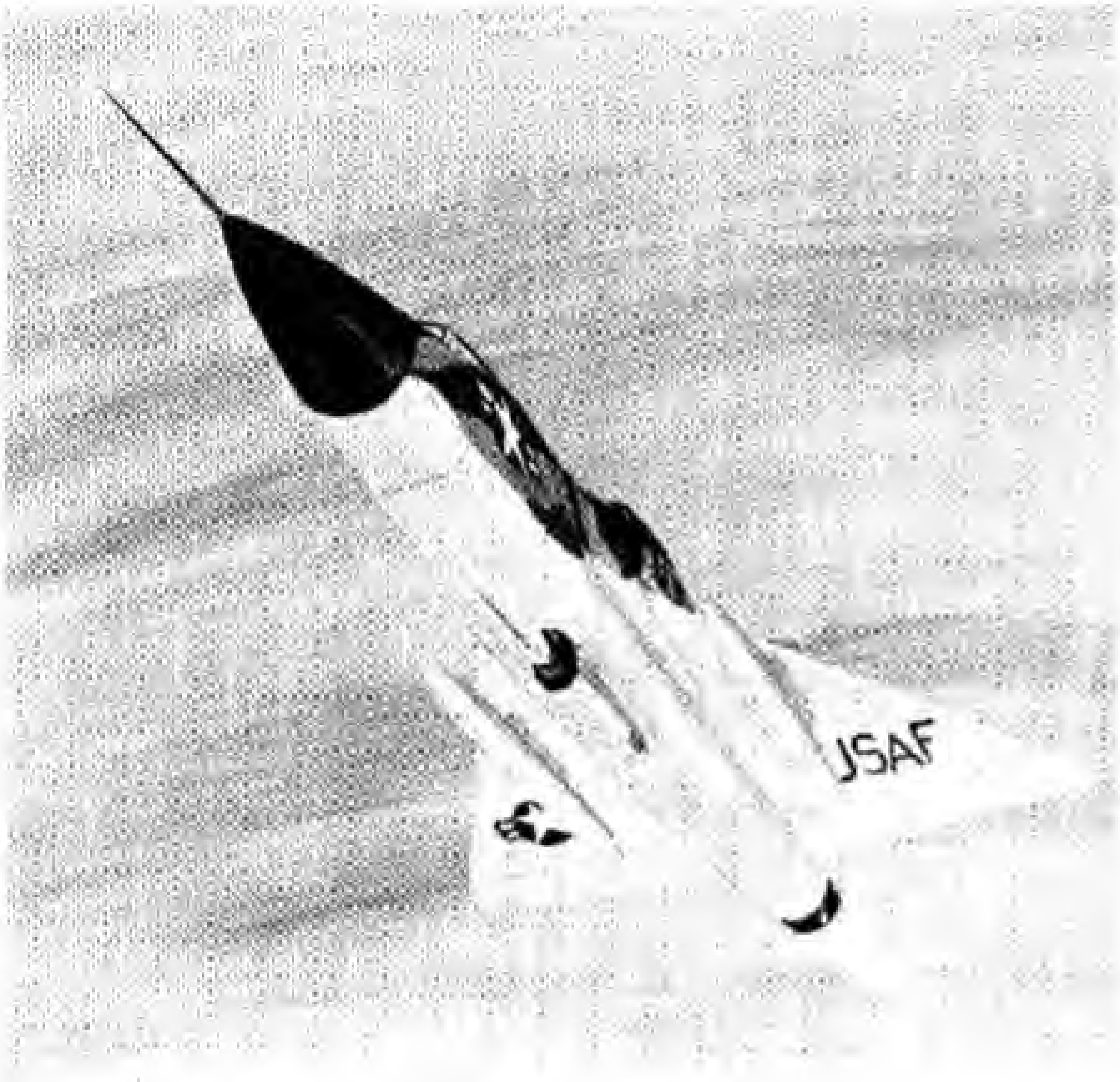
F-111 Vulcan Armament System



F-111 Vulcan Armament System

on the maximum use of gun components already in production at General Electric for the Navy A-7E and the Air Force F-4E for economics and proven reliabilities. These systems went into production for the F-14 in 1970.

The Linkless Feed System holds 676 rounds of M50 series 20mm ammunition. This system is double-ended. It feeds new ammo to the gun from its storage drum, and returns spent cases, duds and cleared rounds back to the drum.



F-106 Vulcan Armament System

Loading is accomplished by an adapter that hooks on to the gun's transfer unit, and feeds in new ammo while removing the spent cases, etc. from the system.

A General Electric "Linkless Ammunition Loading System" (LALS) provides the loading adapter, new ammo and removes the empties.

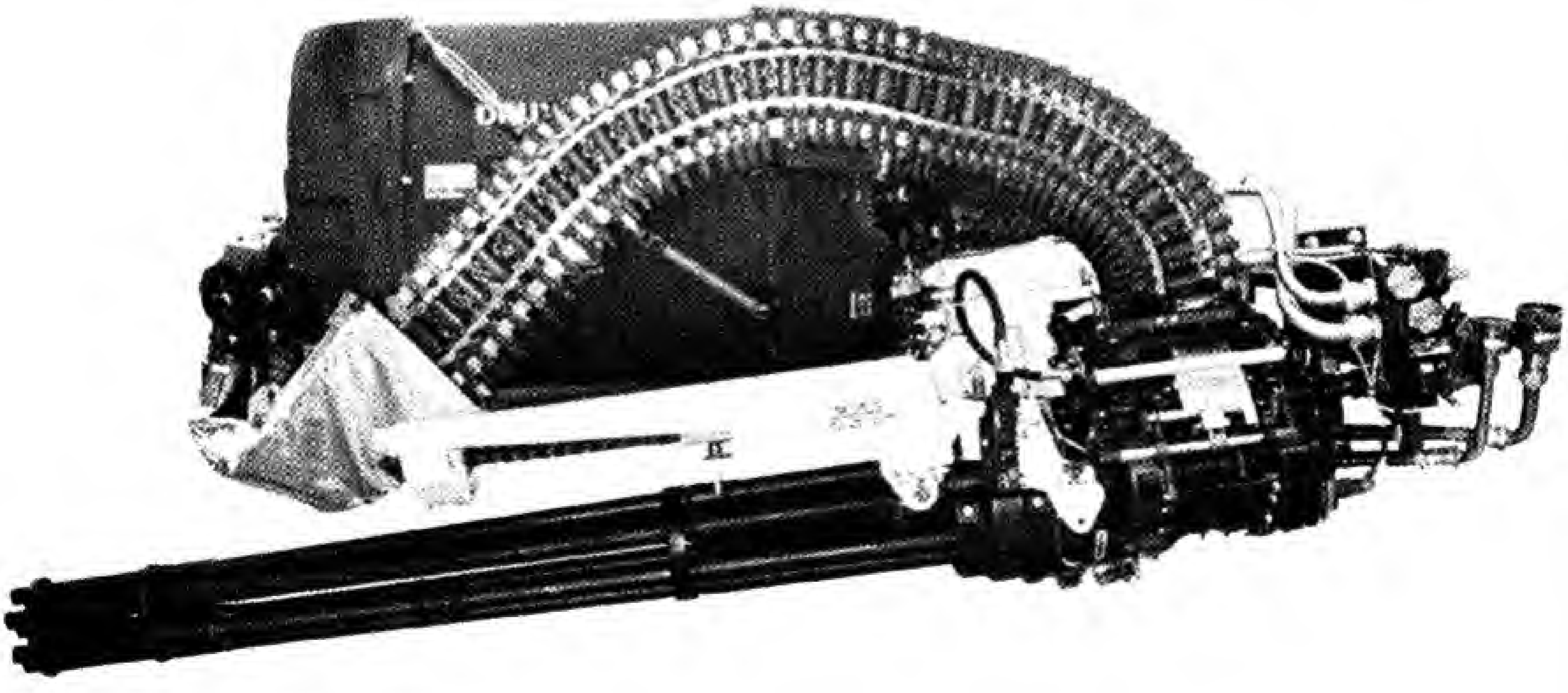
Gun clearing uses the Automatic Clearing Sector System after each burst to provide hold-back clearing in the gun.

F-15. The fixed-forward firing Vulcan M61A1 20mm Gun Armament System for the U.S. Air Force's F-15 went into production at General Electric in 1972. The Double-Ended Linkless Feed System is used and holds 940 rounds of M50 series 20mm ammo.

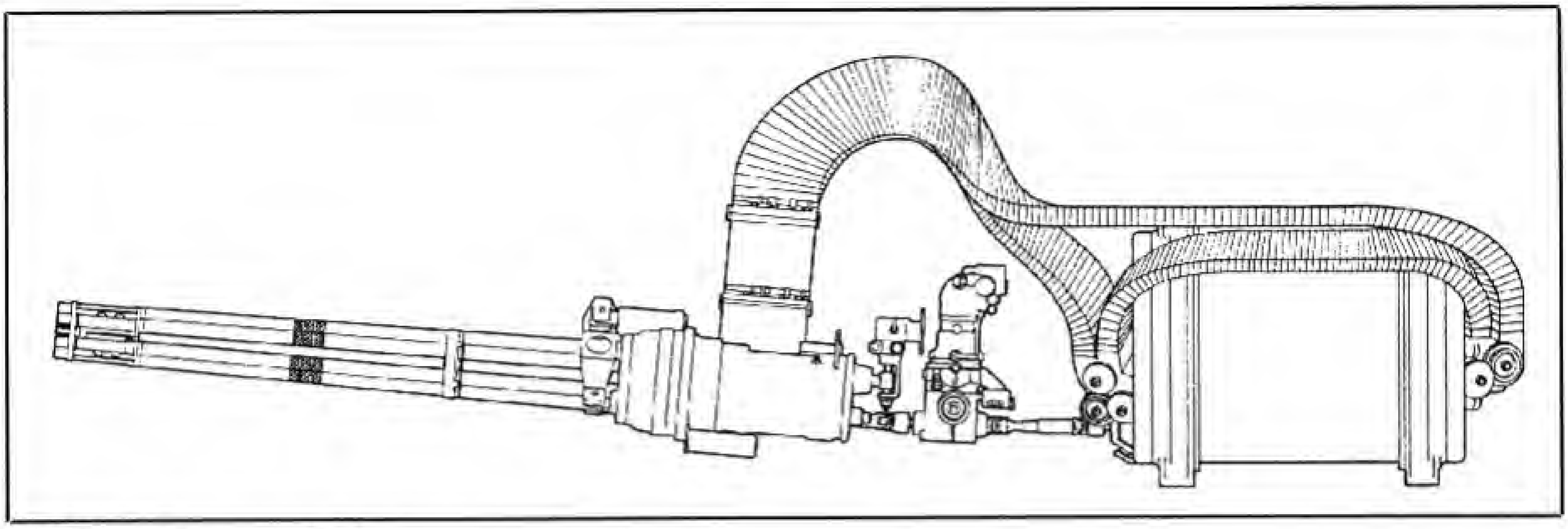
The gun is mounted in the starboard wing root, aft of the engine inlet. The gun fires at 6000 spm (option of 4000 spm). The ammo storage drum is mounted vertically in the middle of the aircraft behind the pilot's station. Ammo is provided to the gun from the drum by a conveying system, which also returns the empty cases, duds and cleared rounds to the drum from the gun.

New lightweight reinforced plastics are used in parts of the drum. Other lightweight materials are used in other locations which all add up to a significant weight savings for the F-15.

New ammo is loaded through an access door in the bottom of the aircraft. A linked belt brings the new ammo in, where it is stripped of the links. The links, spent cases, etc., are removed and disposed of into

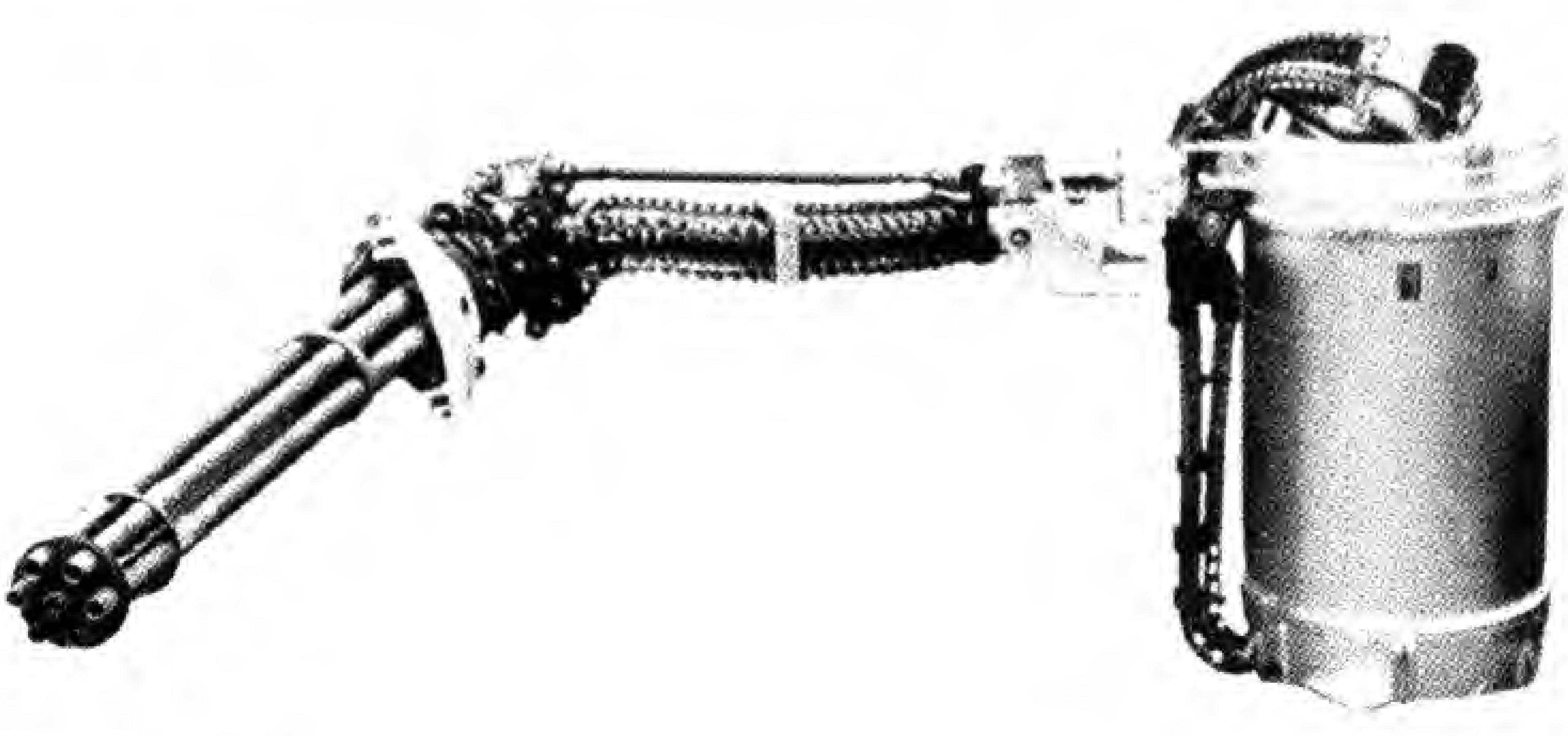


F-106 Vulcan Armament System



F-14 Vulcan Armament System

F-14 Vulcan Armament System



F-15 Vulcan Armament System

F-15 Vulcan Armament System

outside containers.

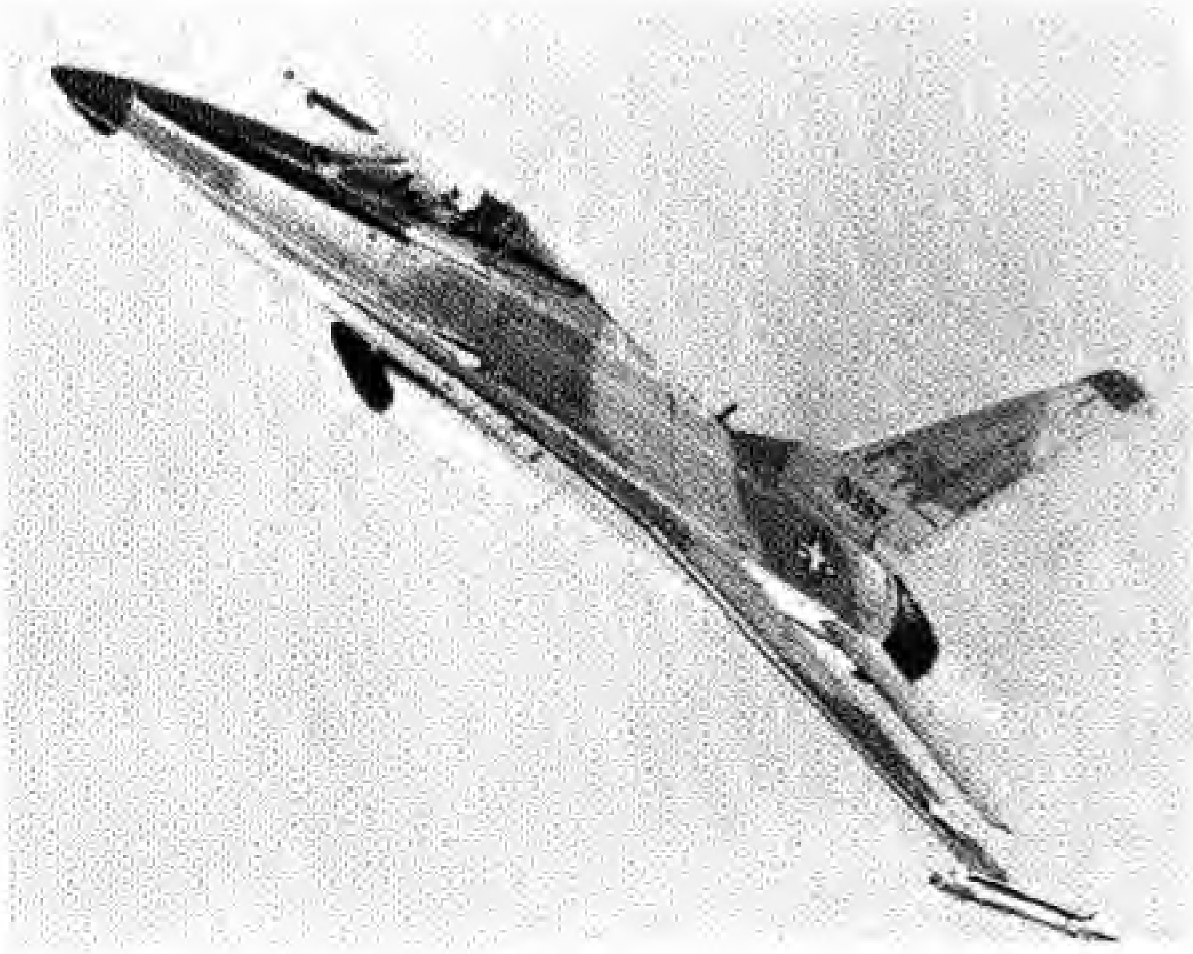
Gun clearing takes place after each burst automatically during gun coast down from steady state firing rate. The gun bolts are placed in a hold-back condition to avoid cook-offs.

F-16. The U.S. Air Force F-16 air combat fighter is armed with the Vulcan M61A1 20mm Armament System what includes the double-ended linkless feed system. These systems went into production in 1978.

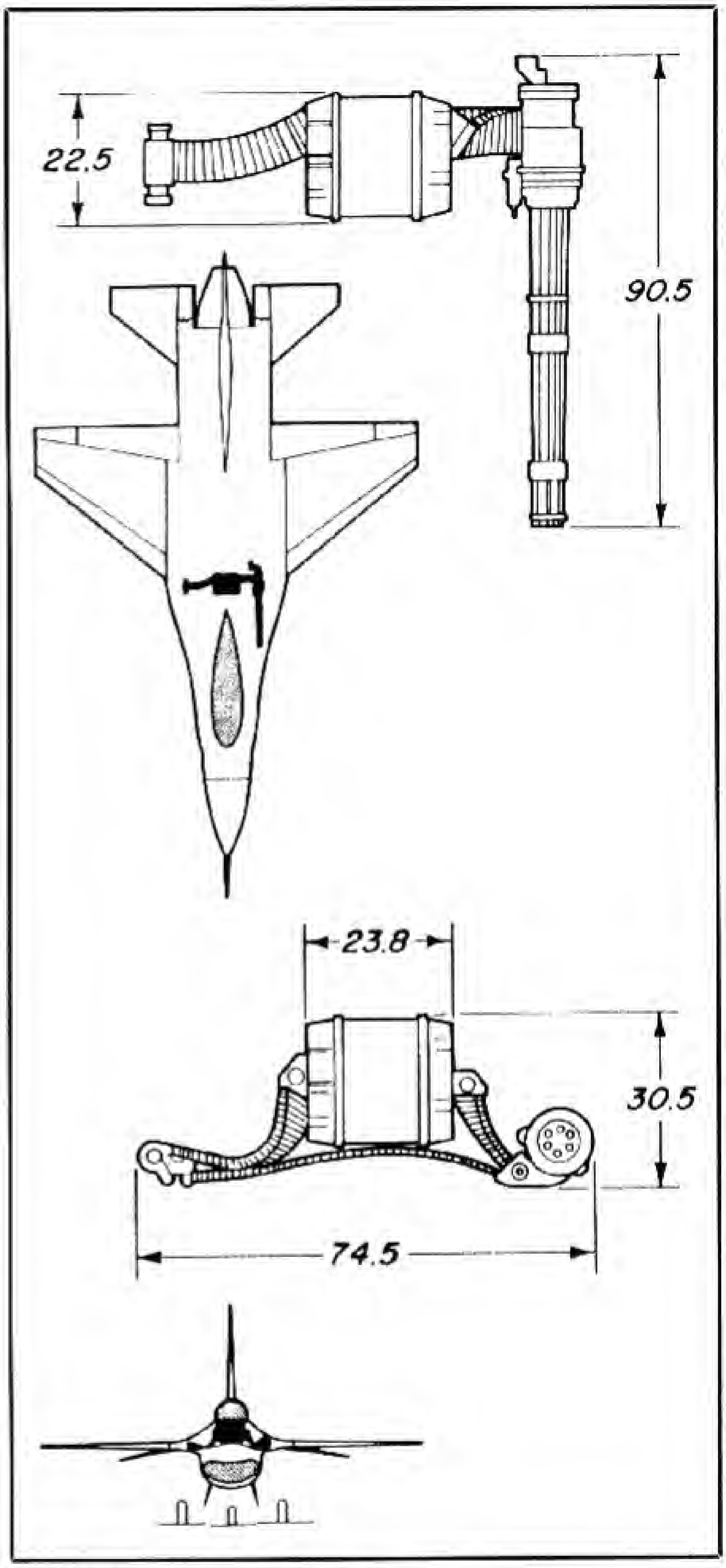
The gun fires at 6000 spm and is mounted on the port side of the fuselage with the gun's muzzle just about even with the pilot's seat.

The Linkless Feed System features new lightweight designs using Fiber Reinforced Plastics. The system holds 512 rounds of ammo. The drum is located behind the pilot's cockpit, in the middle of the ship in a horizontal cross-ship mode.

The drum exit is close to the gun's transfer-feeder unit. Ammo is conveyed to the gun and empty cases, duds and cleared rounds are conveyed back to the drum via the conveyor which runs through the loading unit located below the starboard wing.



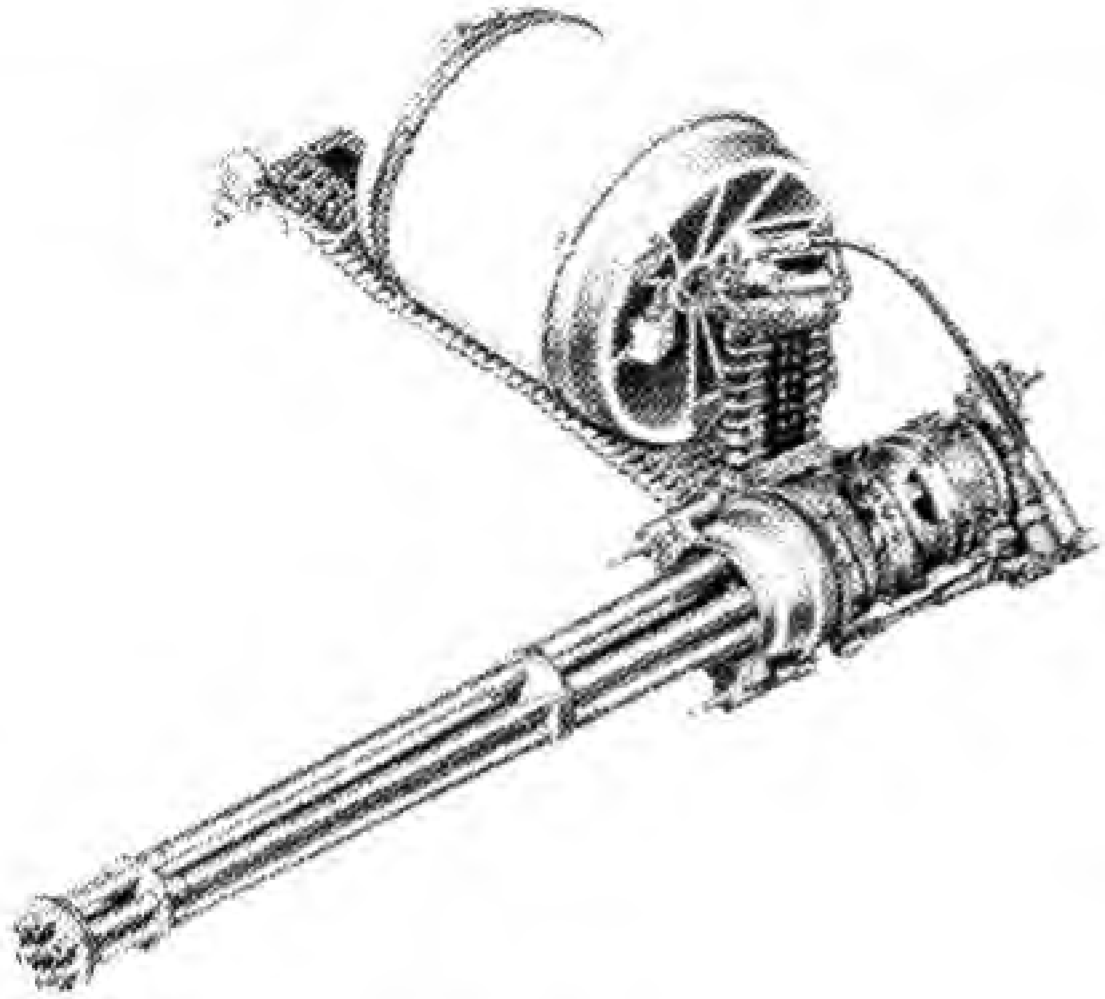
F-16 Vulcan Armament System



F-16 Vulcan Armament System

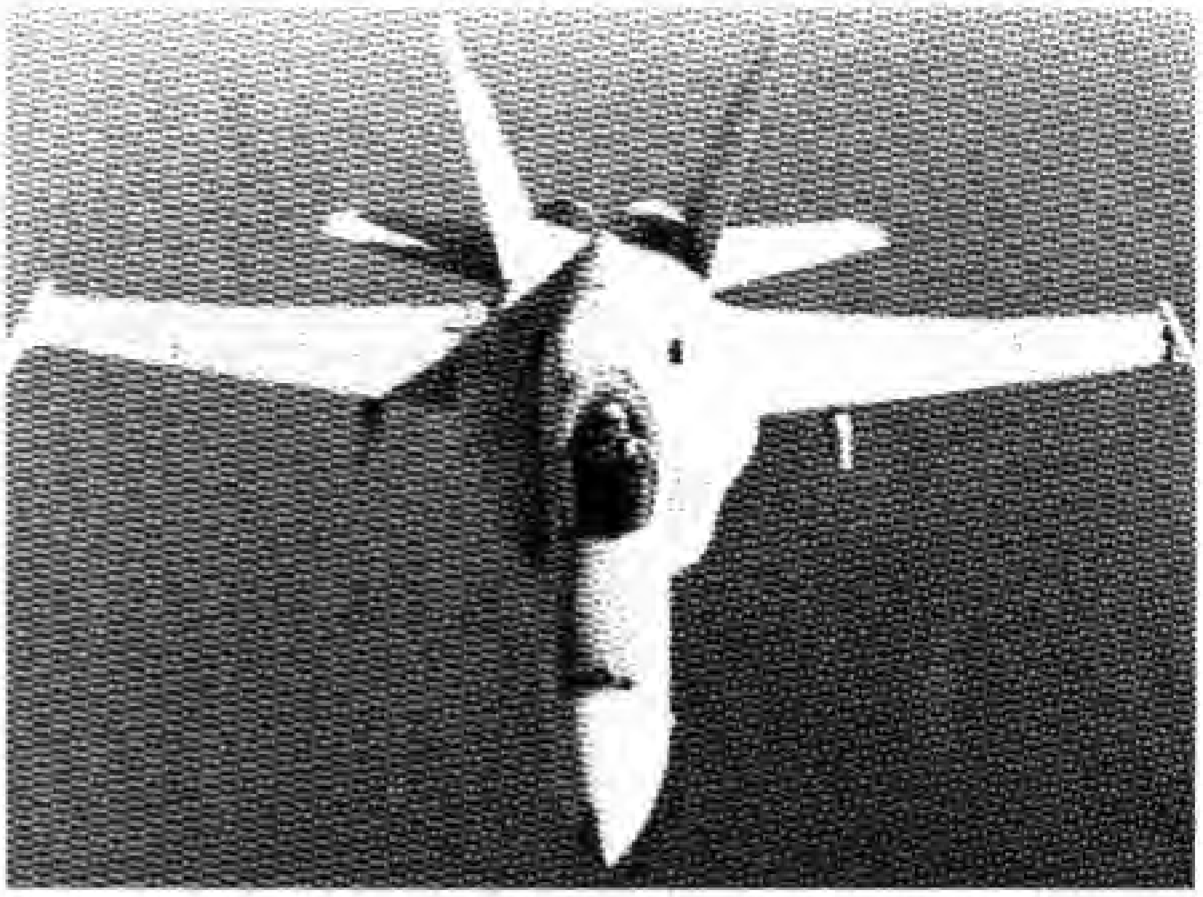
Loading is accomplished by using the Linkless Ammunition Loading System (LALS) for reduced aircraft turn-around time. The F-16 is also compatible with the delinking loader (M14 link).

Hold-back gun clearing takes place after each burst.



F-16 Vulcan Armament System

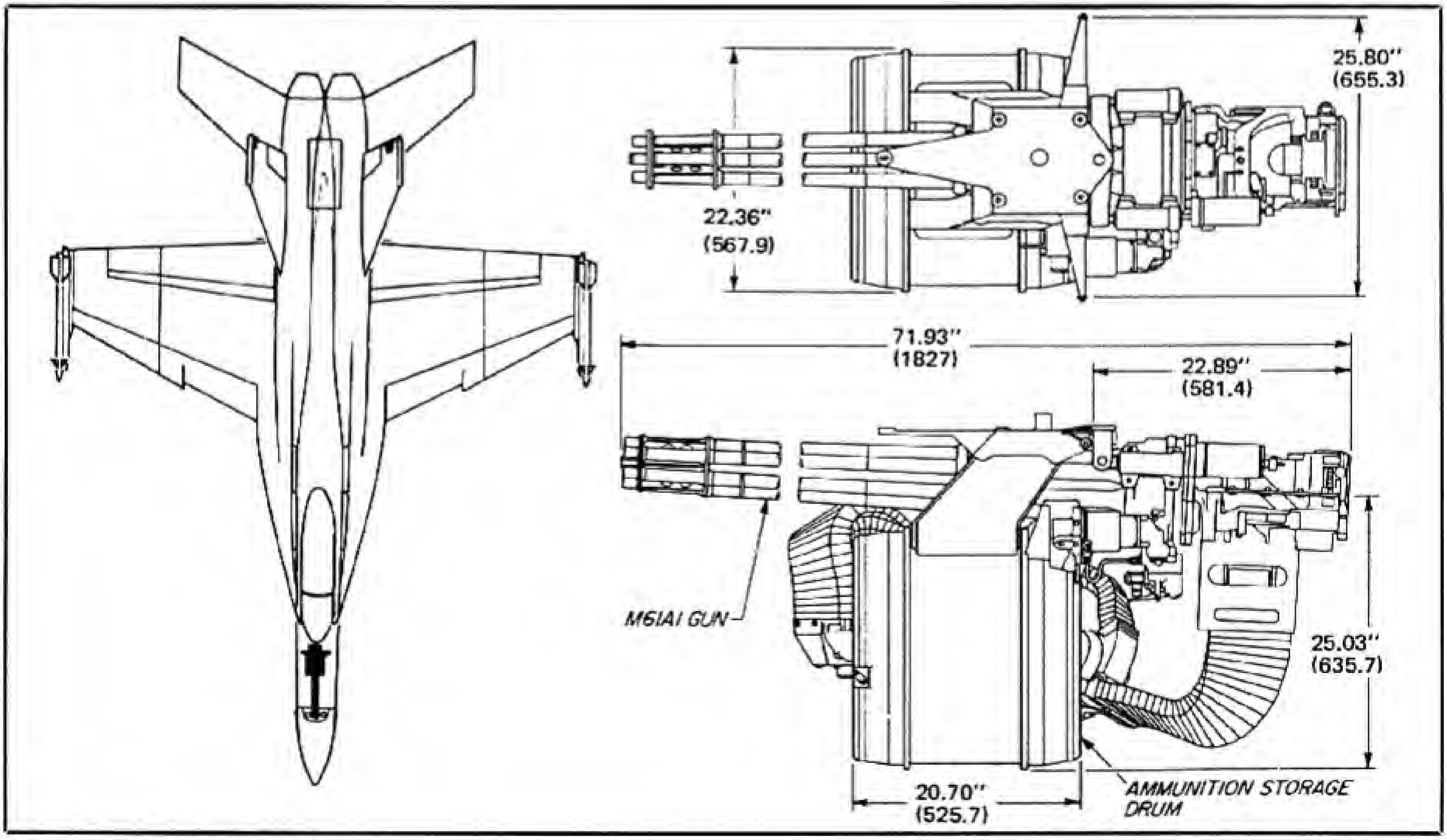
F-18. The U.S. Navy's F-18 multi-mission fighter is armed with the Vulcan M61A1 20mm gun Armament System which includes the double-end linkless feed system. This system started in production at General Electric in 1979.



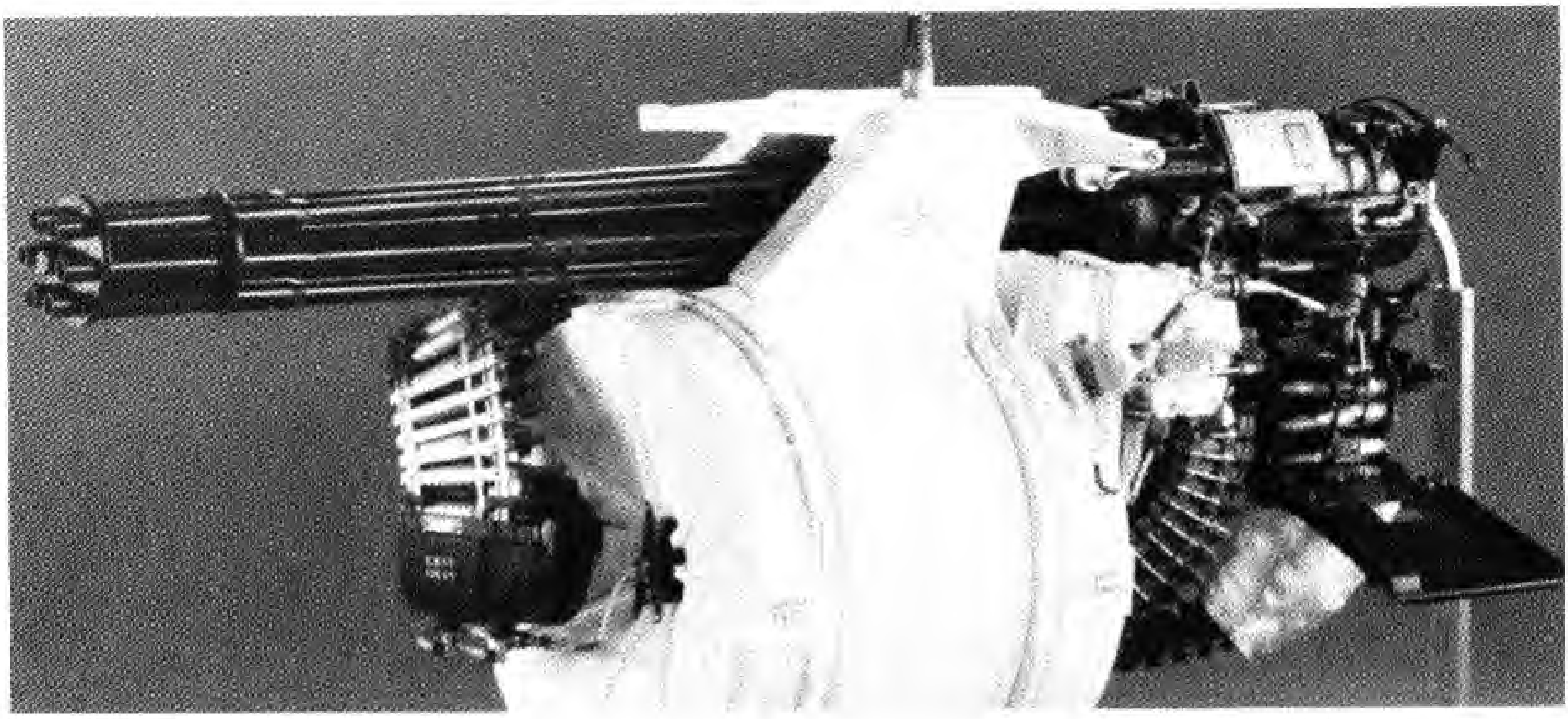
F-18 Vulcan Armament System

The system is mounted on the centerline of the aircraft in the nose section in front of the pilot's cockpit. The gun fires at 6000 spm (4000 option), and the system contains 570 rounds of M50 type 20mm ammo.

Most of the systems components are the same or similar to those provided on other aircraft, except the F-18 features a new high capacity storage drum.


25.80"
(655.3)
22.36"
(567.9)
71.93"
(1827)
22.89"
(581.4)
M61A1 GUN
25.03"
(635.7)
20.70"
(525.7)
AMMUNITION STORAGE DRUM

F-18 Vulcan Armament System



F-18 Vulcan Armament System

More efficient packaging of rounds was accomplished within the same overall space of the drum. Lightweight designs and materials were also utilized for large weight savings with extra stored ammo.

All components are mounted on a pallet. The storage drum is mounted below the pallet, and the Vulcan gun is attached above the pallet at its recoil adapters. Further, gun support is provided at the muzzle by a gun gas deflector and bearing which is a part of the aircraft. This modular pallet design simplifies the installation and removal of the complete armament system from the aircraft.

A part of the transfer-feeder unit on the gun is the loading adapter. It is used to interface with the Linkless Ammunition Loading System (LALS) which is a standard Navy loader provided by General Electric. This system loads at a rate of 400 shots per minute. Automatic hold-back clearing is used after every burst.

AMX. The Stallion Air Force AMX fighter aircraft is armed with the Vulcan M61A1 20mm Gun System which includes the double-ended linkless feed system, and which was designed and produced by General Electric.

The gun fires at 4000 spm, and the ammunition capacity of the system is 403 rounds of 20mm M50 series and RAUFOSS multi-purpose ammunition.

The gun is on the centerline of the fuselage and located low beneath the nose. The storage drum sits horizontal and cross-ships in front of the pilots cockpit.

Automatic loading is provided by attaching a ground support loading unit to the gun's transfer-feeder unit and cycling the ammo system and gun.

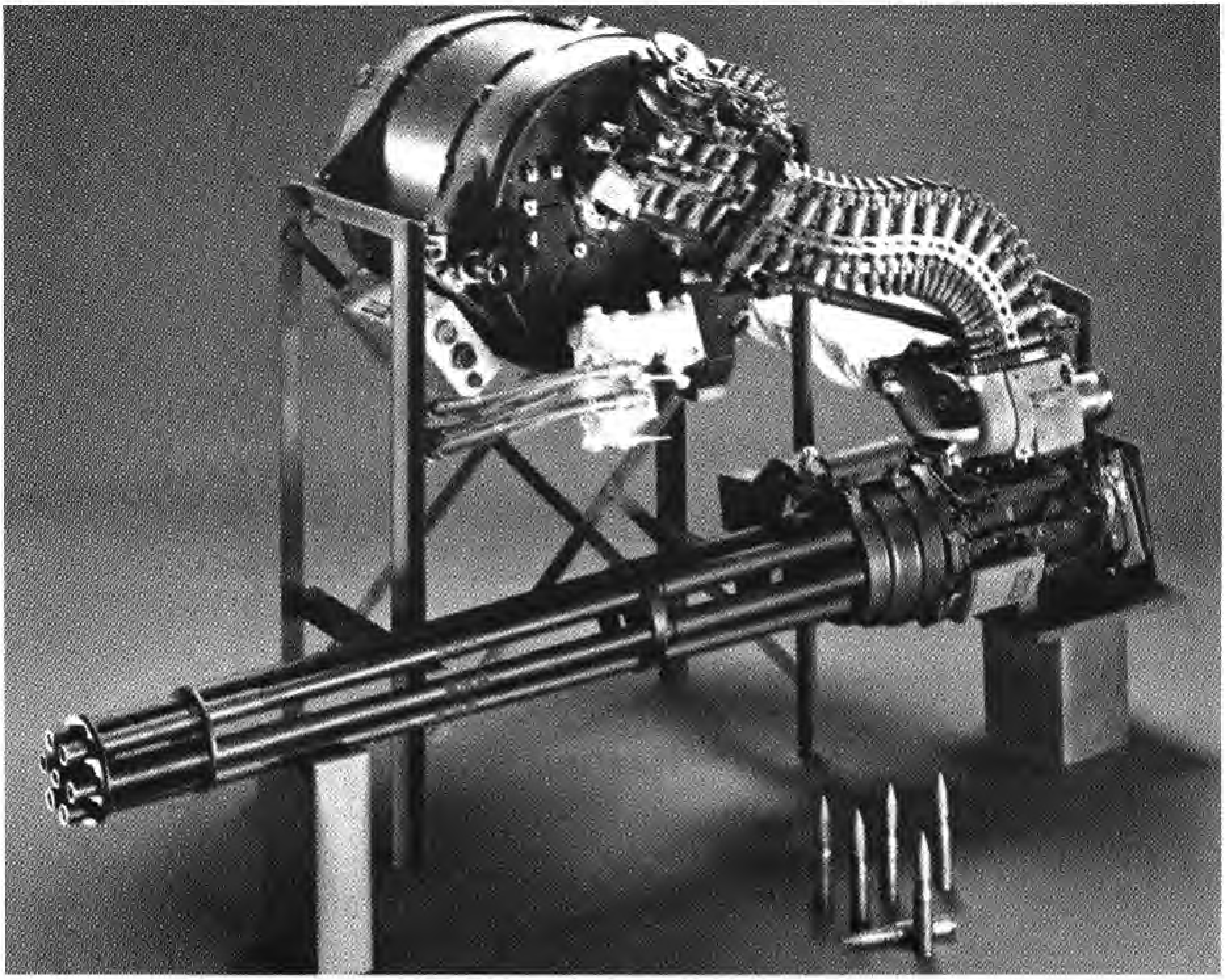
The firing sector is in the six o'clock position. Hold-back gun clearing is provided.

2. Phalanx

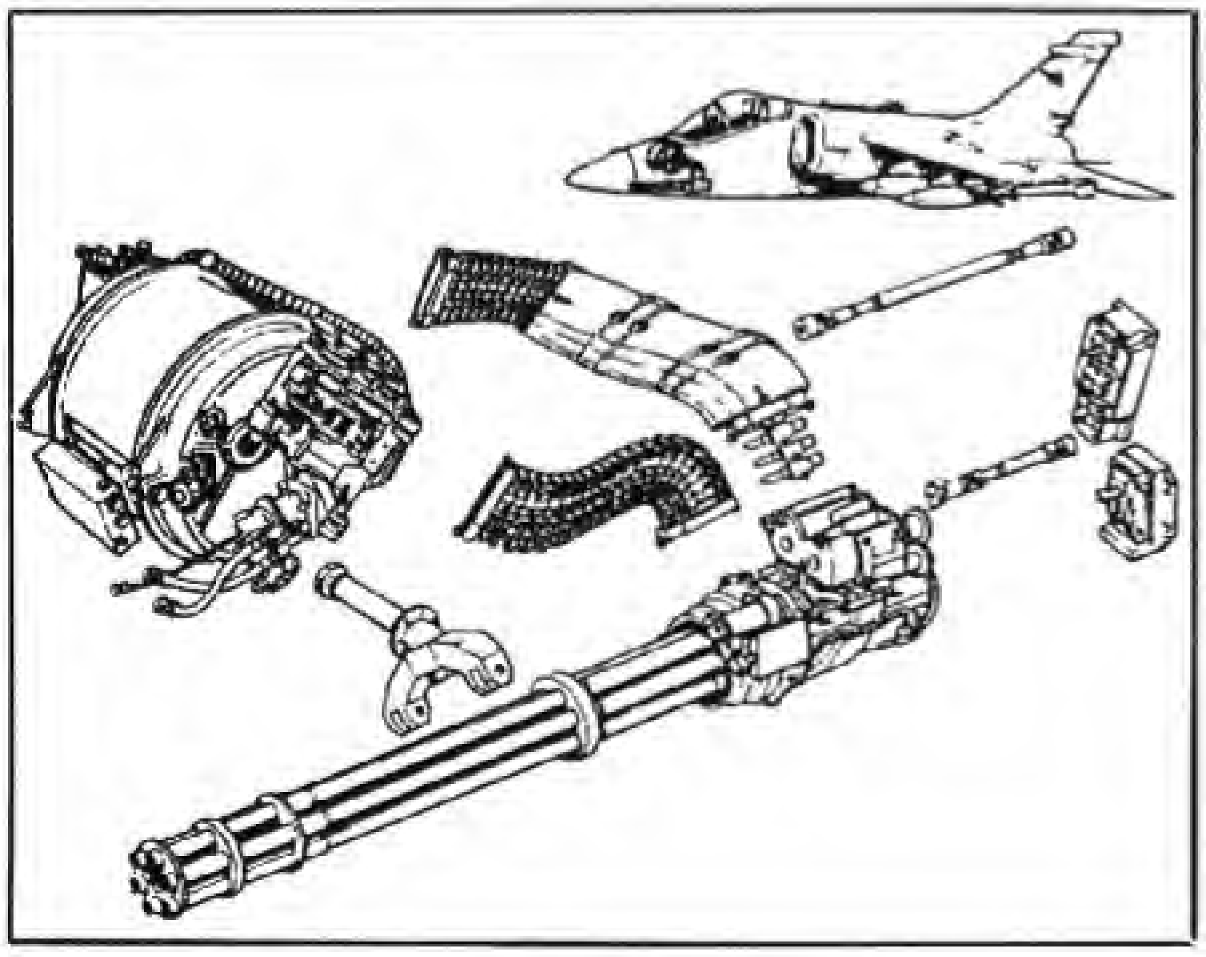
The Phalanx Close-In Weapon System provided to the U.S. Navy by General Dynamics Pomona uses the Vulcan M61A1 20mm gun and the double-ended Linkless Feed System both designed and manufactured by General Electric beginning in 1979.

The Phalanx is a shipboard installation used as a defense against anti-ship missiles.

AMX



AMX



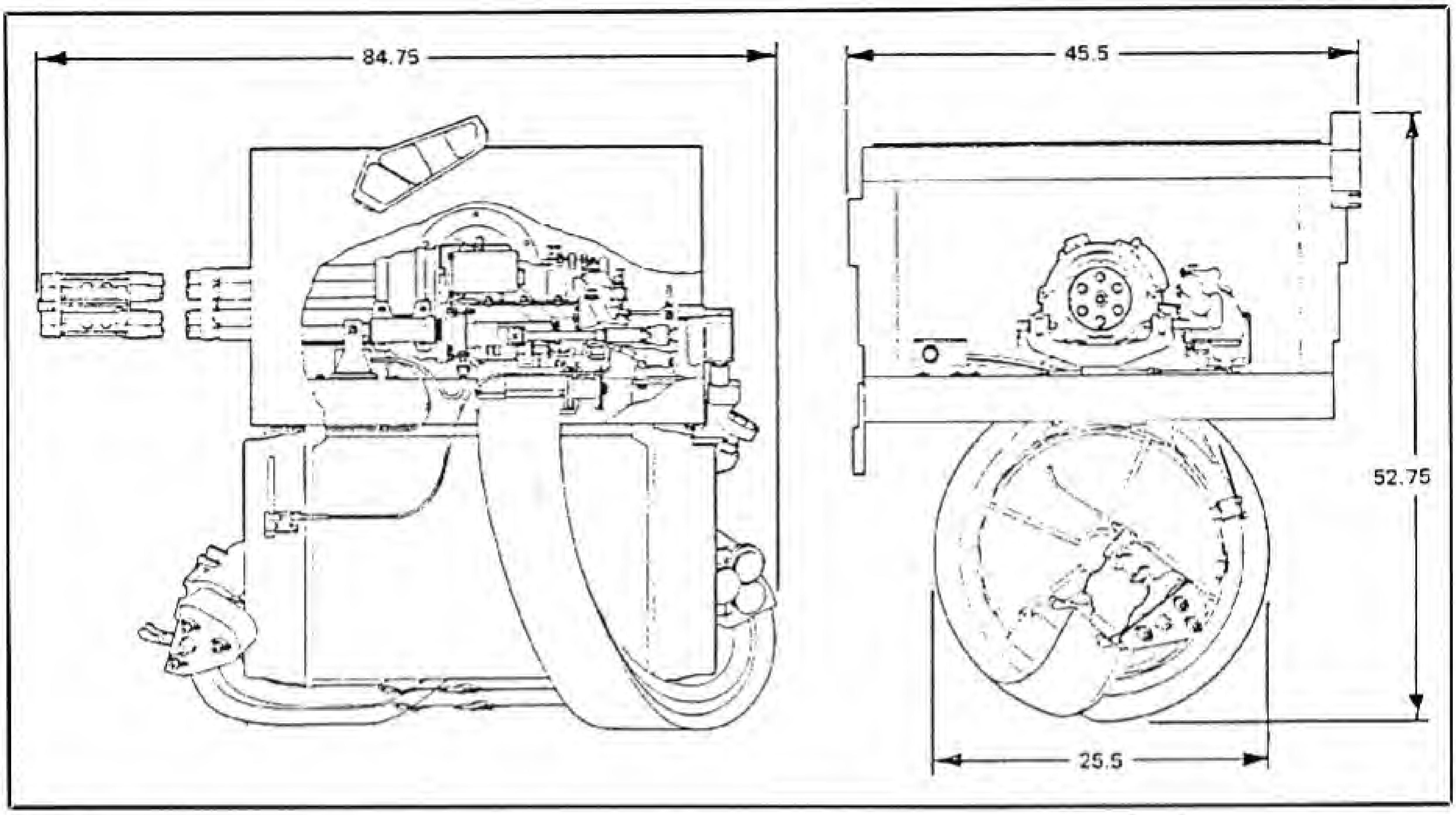
AMX

The Vulcan gun firing rate is 3000 spm, fires the Mk 149 standard Phalanx round, and ia also compatible with the M50 series of 20mm ammunition. The electrically primed ammunition is fully shielded against electromagnetic interference, making it safe for shipboard environment.

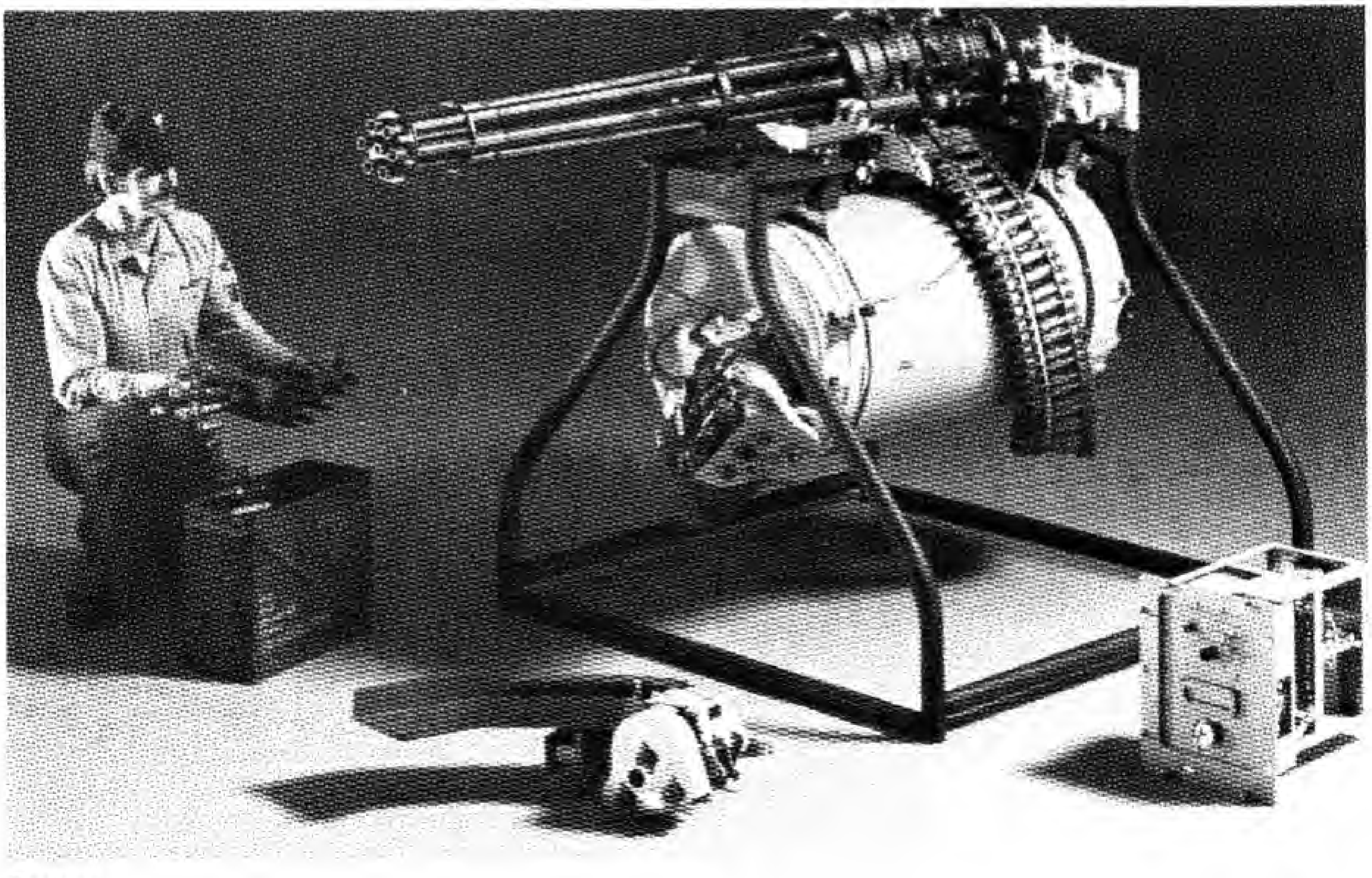
The Linkless Feed System contains 980 rounds and is loaded at the exit of the storage drum by mounting the Phalanx Loader which can load safe, linked ammo at rates of 400 rounds per minute. The Linkless Ammunition Loading System (LALS) is also compatible with Phalanx by using an interface unit.

The Vulcan gun and the Linkless Feed System are all mounted to the Phalanx cradle which is the elevation gimbal of the turret system.

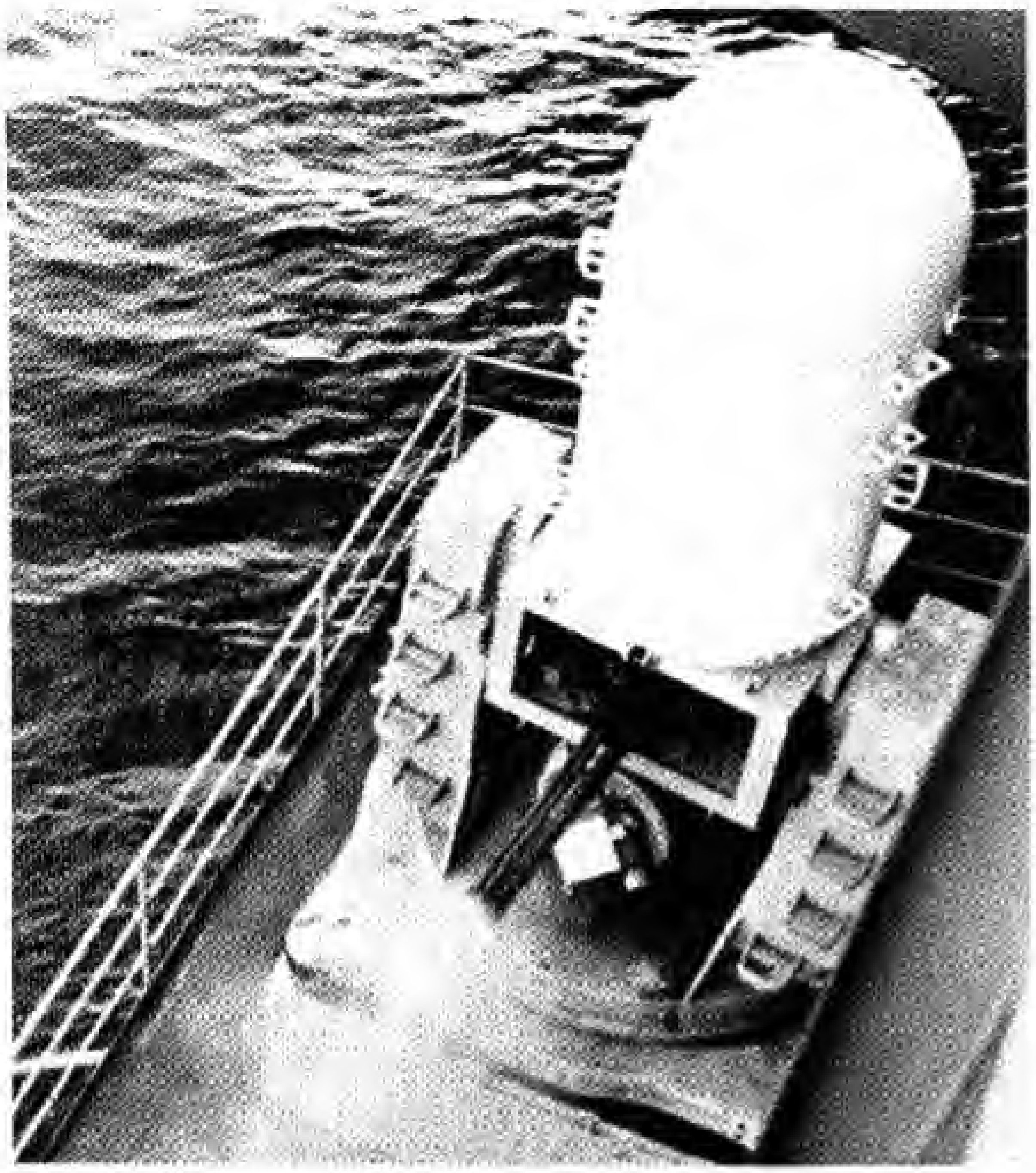
The Phalanx fire control system initiates the control to start a gun burst, to stop the burst and to clear


84.75
45.5
52.75
25.5

Phalanx



Phalanx

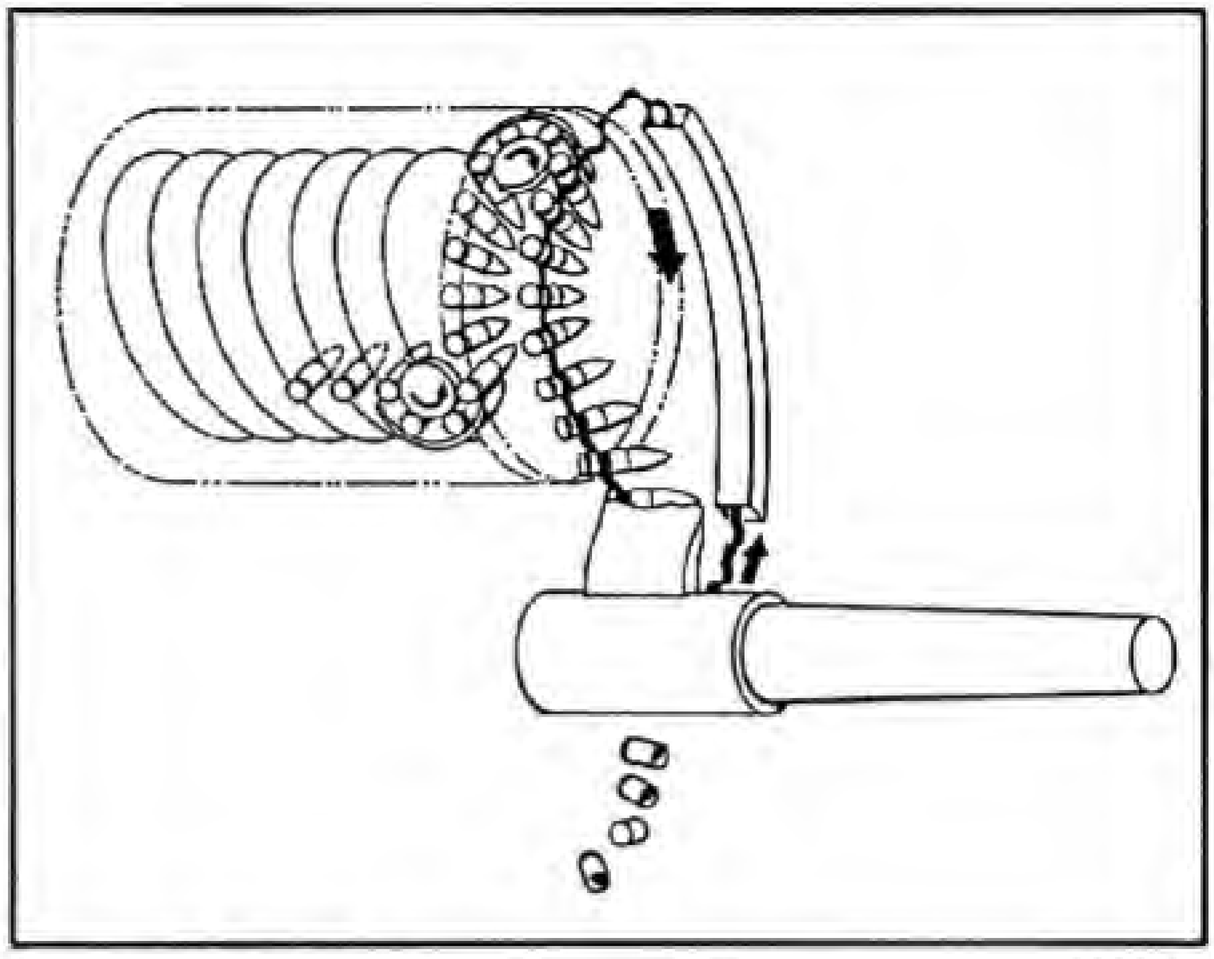


Phalanx

the gun after the burst. Hold-back automatic clearing takes place after each burst.

3. SUU-16/A Gun Pod

The "Vul-Pod" was provided to the U.S. Air Force and designated the SUU-16/A Gun Pod. The U.S. Army designation was XM12. Both pods are alike and started in production at General Electric in 1965.



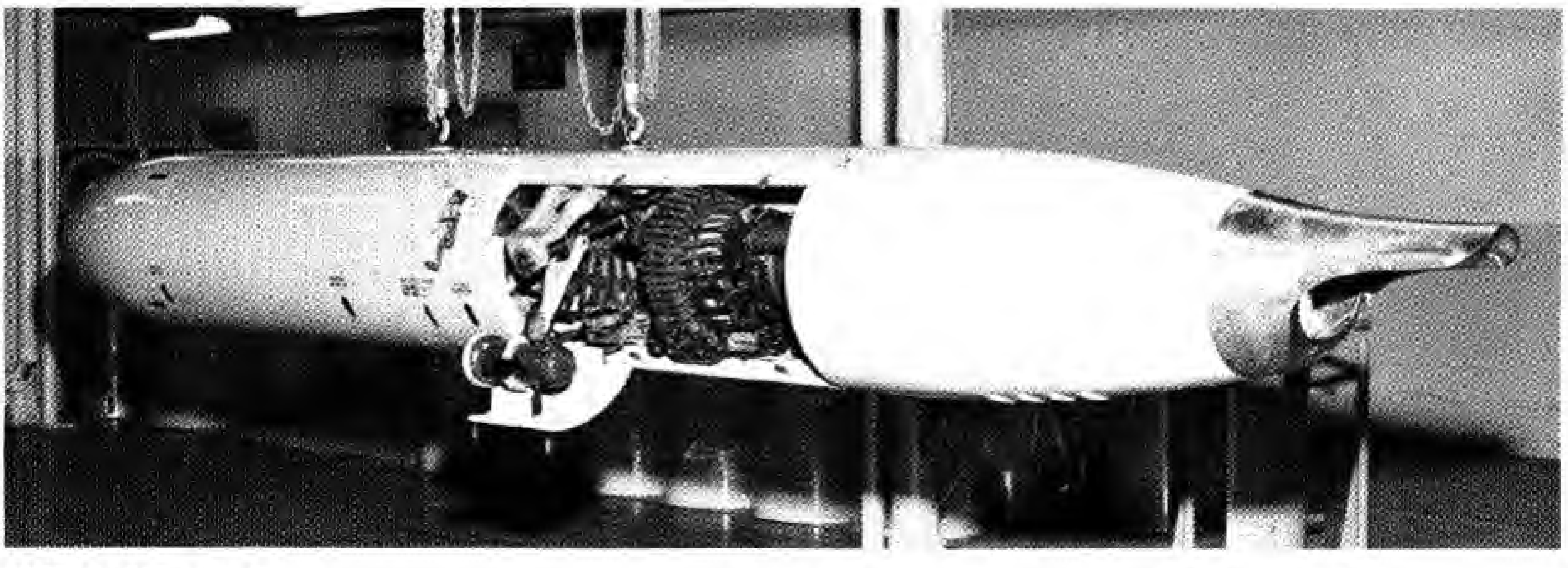
SUU-16/A Gun Pod

The Vul-Pod contains the Vulcan M61A1 20mm Gun and a Linkless Feed System, Single-Ended.

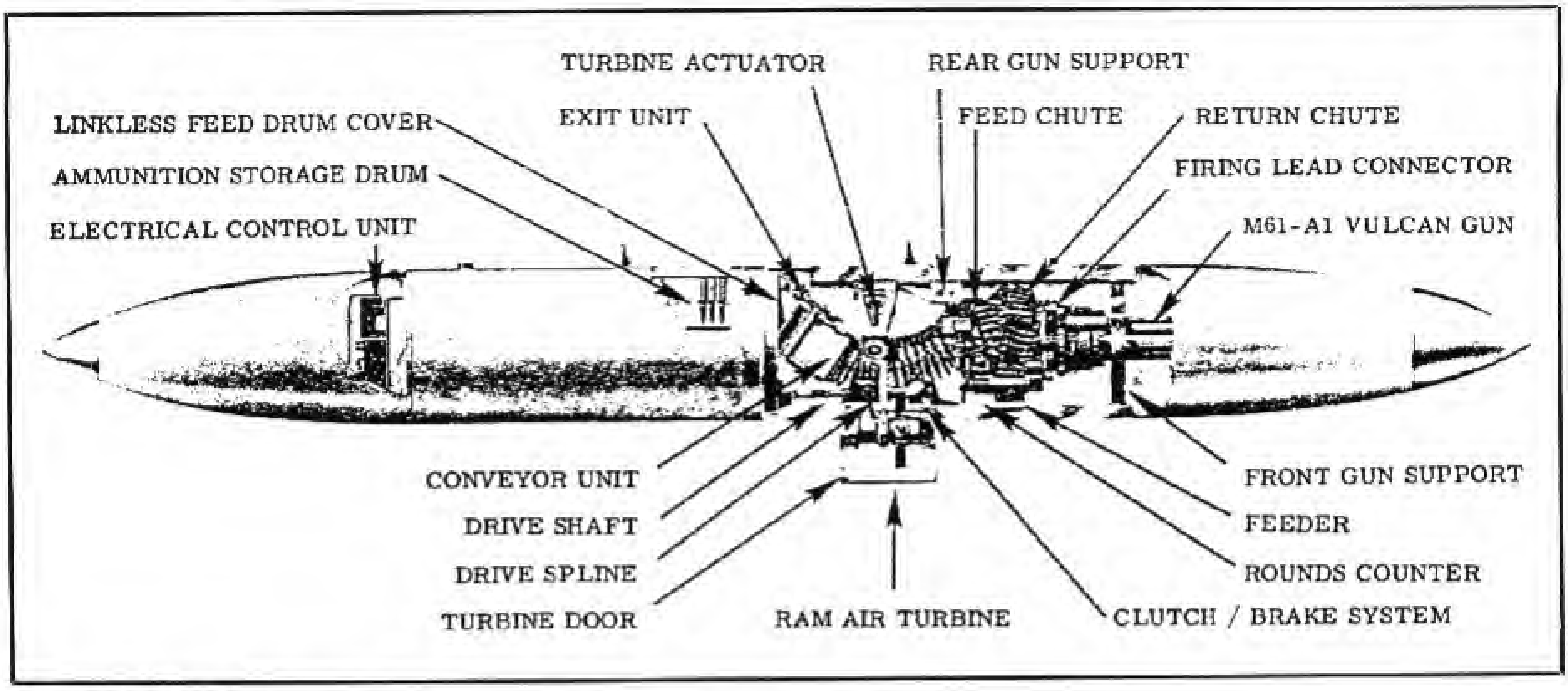
The Vul-Pod is an externally stored weapon system for use by high performance aircraft engaged in air to ground missions. The pod features a self-contained, ram air-turbine drive system which operates its Vulcan gun at 6000 spm throughout a wide range of aircraft speeds.

Two or more Vul-Pods can be carried by an aircraft, allowing more projectiles on target when fired together, or a longer firing time if fired separately.

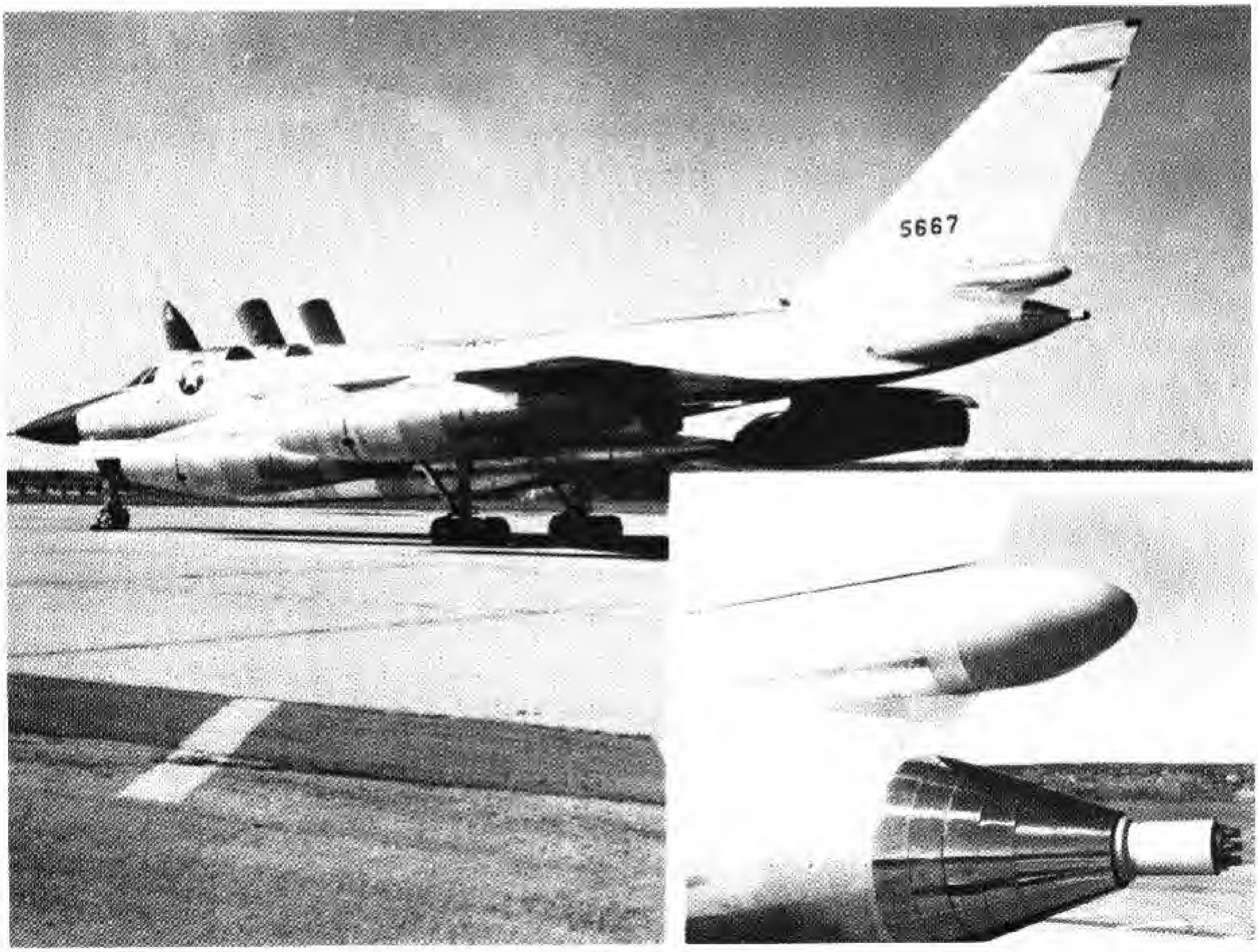
The Linkless Feed System is similar to that used on the F-105D except it is single-ended. This system delivers ammo to the gun as on the F-105D. The gun fires but ejects the spent cases and duds overboard



SUU-16/A Gun Pod


TURBINE ACTUATOR
REAR GUN SUPPORT
LINKLESS FEED DRUM COVER
EXIT UNIT
FEED CHUTE
RETURN CHUTE
AMMUNITION STORAGE DRUM
FIRING LEAD CONNECTOR
ELECTRICAL CONTROL UNIT
M61-A1 VULCAN GUN
CONVEYOR UNIT
FRONT GUN SUPPORT
DRIVE SHAFT
FEEDER
DRIVE SPLINE
ROUNDS COUNTER
TURBINE DOOR
RAM AIR TURBINE
CLUTCH / BRAKE SYSTEM

SUU-16/A Gun Pod



B-58 with Vulcan

rather than returning them to the drum for storage.

The Linkless Feed System contains 1200 rounds of 20mm ammo of the M50 series. The pod has a built in loader at the exit to the drum. It can be loaded by an external handcrank that back-loads ammo into the storage drum. The incoming ammo is belted, and its link is stripped at the loader and discarded out of the pod. Gun clearing (Hold-Back) is provided at the end of every burst.

4. Bombers B52H and B58

Tail defense was provided to the U.S. Air Force bombers, the B52H and B58. The Vulcan M61 20mm guns were provided by General Electric starting about 1957. This was before the time of the M61A1.

The turret radar directed tail defense armament systems were designed and made by Emerson Electric Company.

Linked ammunition belts transported live ammo from special storage containers to the Vulcan M61 gun's delinking feeder. The stripped links, empty cases, duds and cleared rounds were discarded overboard.

Hold-back clearing was provided after firing and the gun stopped. The clearing sector solenoid was energized and the gun turned over at least two revolutions to put all the gun bolts into hold-back.

The guns fired up to 4000 spm because of the same early difficulties with linked transport and storage systems. The ammo containers were a good improvement since they laid layers of the ammo belt horizontal on separate shelves running fore-aft directly behind the guns. The B52H was built by Boeing and the B58 by CONVAIR.

5. Side-Fire

The U.S. Air Force "side-fire" operations on the AC-119 and the AC-130 used Vulcan M61A1 20mm guns and systems supplied by General Electric.

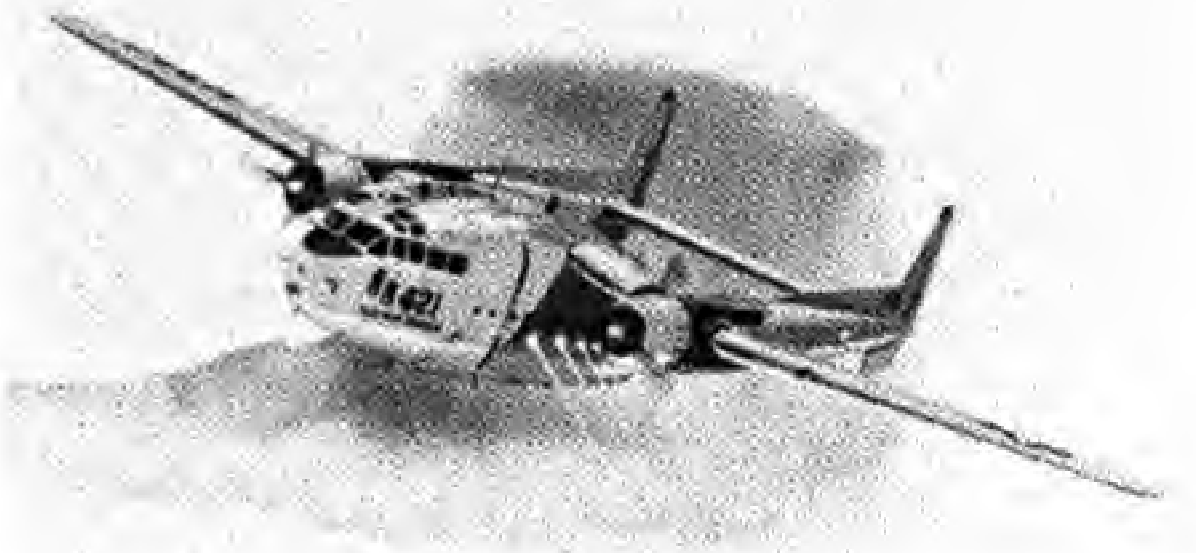
The AC-119 carried miniguns and two M61A1 guns. The guns fired out the port side of the aircraft while it was in a banked pilon turn aiming at its ground target located at the center of the turn. The AC-119 was the follow on operation from the original Side-Fire, the AC47 which used only miniguns (7.62mm).

The ammunition supply was obtained by taking the one-way Linkless Feed Systems from some SUU-16/A Vul-Pods. Extra ammo was carried on board the crew-served AC-119 so that reloading was done in the air while on missions.

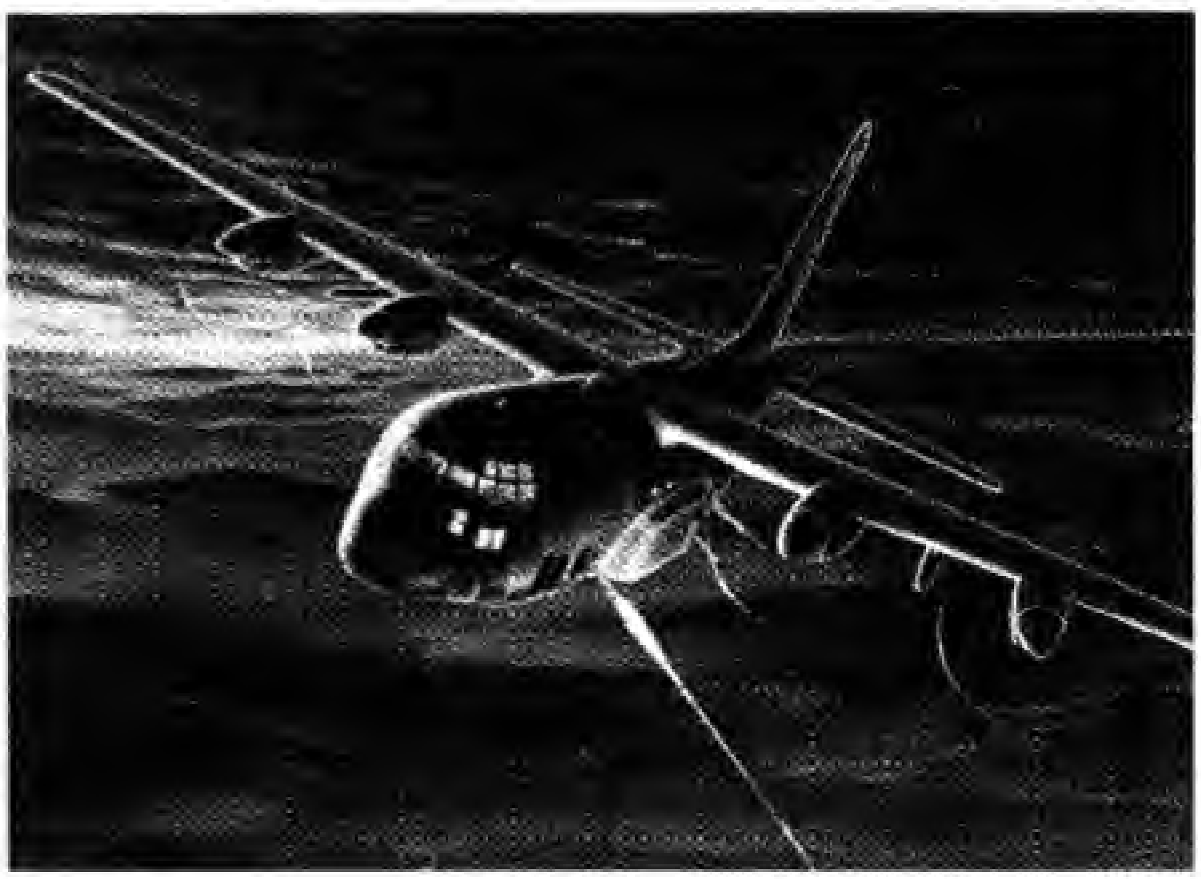
The AC-130 which came later also utilized two M61A1's in its Side-Fire operations.

The ammunition system was a specially designed linked system. Large ammo cans stored ammo in a fire-hose hung fashion, which were long vertical loops hung from a top rail. At the exit of the box, the ammo was pulled by a booster until the first loop was taken. The ammo on the top rail supporting the second loop would slide toward the booster. It would fall off the rail as it approached the booster, and allow the following loop to enter the booster behind them. This would continue until all loops were taken. The crew could reload or top off at any convenient time from extra ammo carried on board.

The firing rates up to 4000 spm hold-back clearing was used. The empty cases, duds, cleared rounds and links were kept onboard in open storage bins.

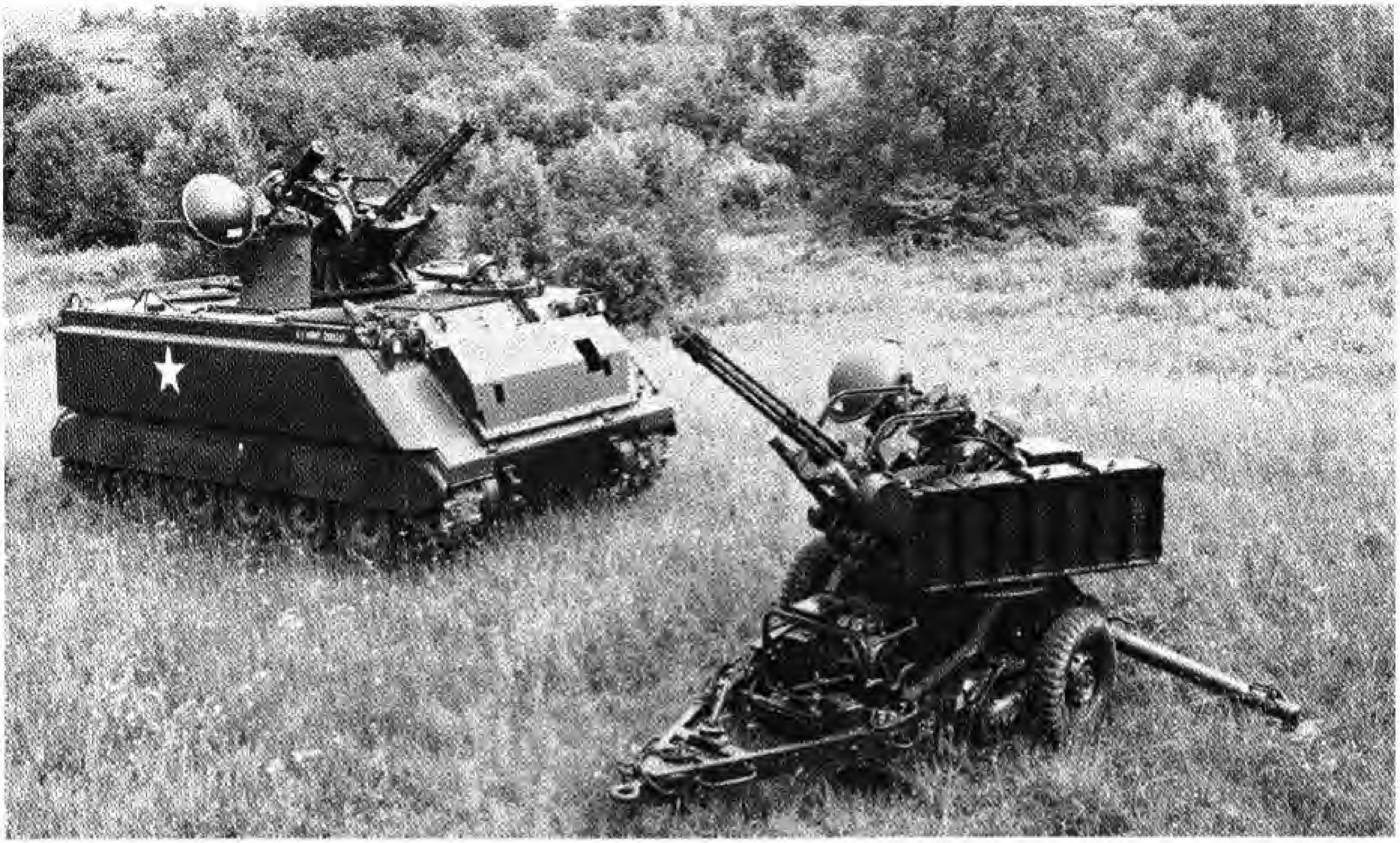


C-119 Gunship



C-130 Gunship

APPLICATION OF VARIATIONS OF THE VULCAN GUN THE M168, M195, M197 and GAU-4/A (20mm)



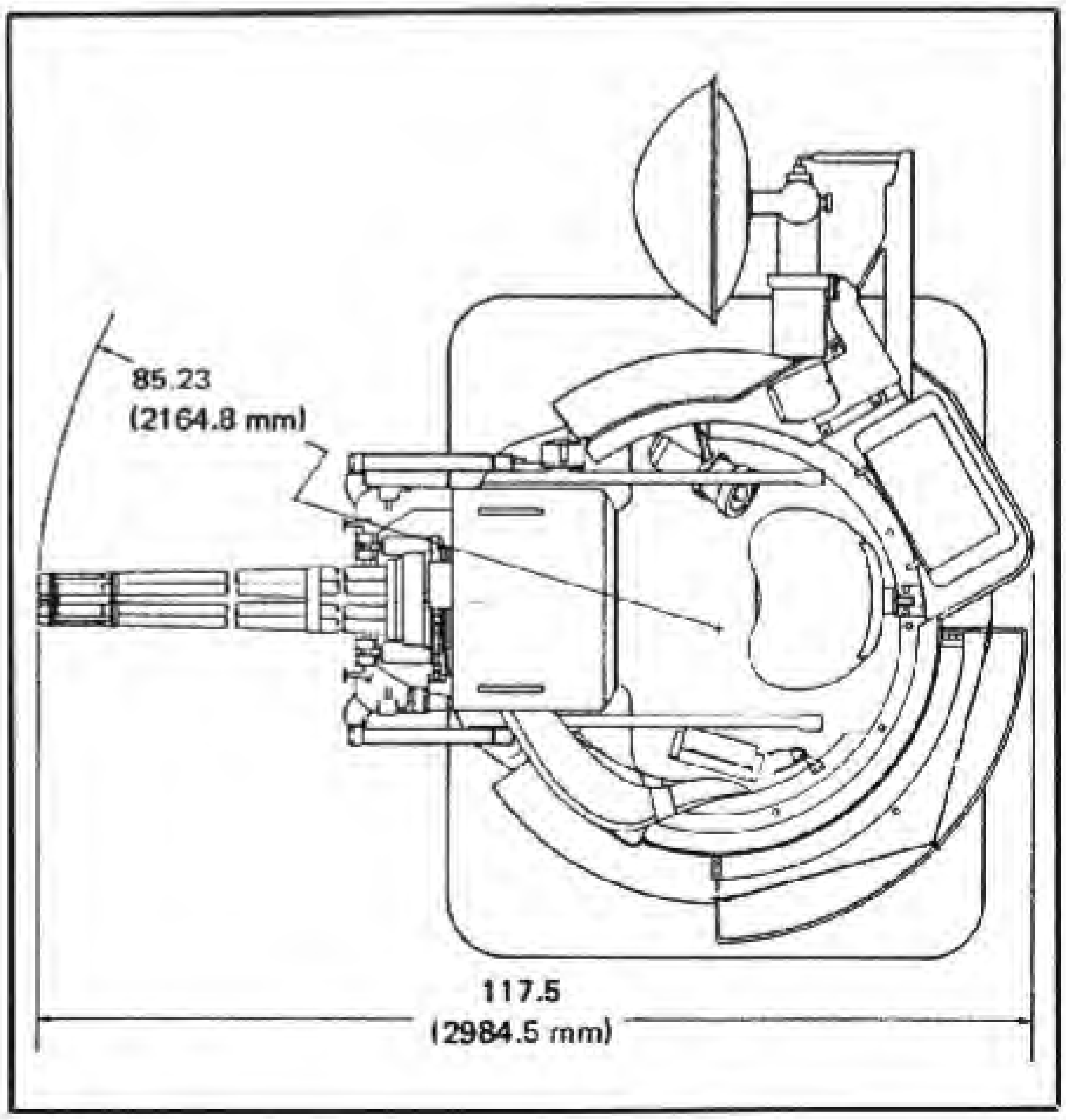
Self-propelled and Towed Version of 20mm Vulcan Air Defense System

1. Vulcan Air Defense System M163A1 (VADS)

The U.S. Army's Vulcan Air Defense System M163A1 utilizes the Vulan M168 20mm gun which is the same as the Vulcan M61A1 gun except that the M168 has different supporting components such as muzzle clamps. These started in production in 1967, and General Electric has produced more than 1000 systems.

The VADS M163 is a lightweight, self-propelled weapon used for close-in defense against ground targets and low flying aircraft. The system is mounted on an M741 chassis capable of cross-country and amphibious operations.

The system is a self-contained turret with the gun mounted on the elevation axis, both of which are mounted on the azimuth axis. The Single-Ended Linkless Feed System is hung from the azimuth axis and extends down inside the crew-serviced vehicle. The drum is horizontal and can be backloaded from inside the vehicle with extra ammo that is carried.



M-163

M163A1 Characteristics

Weight (Combat Loaded)	5200 lbs.
Height	105 in.
Length	191 in.
Wheel Track	100 in.
Ammunition Capacity	2100 rds.
Feed System	Linkless, closed-loop, single-ended
Drive System	Electric
Power Requirements	On-board batteries (recharged by on-board generator or APU)
Ammunition	M246, M50 series, M220 practice round
Firing Rates	1000/3000 spm
Barrel Life	72,000 rds.
Weapon Coverage:	
Azimuth	360°
Elevation	+80°, -5°
Turret Slewing Rates:	
Azimuth	75°/second
Elevation	60°/second
Reliability	10,000 to 20,000 MRBS
Dispersion (80% of rds fired)	12 milliradians or 8 x 18 milliradians or 6 milliradians
Recoil Force Average:	
3000 spm	1800 lbs. (817.2 kg)
1000 spm	600 lbs. (272.4 kg)

The spent cases, etc., are dumped overboard after firing directly from the gun.

The system is radar directed and operator fired, but it can be fired directly by the operator using his gyro lead computing gun sight. The firing rate is 3000 spm with an option of 1000 spm. Hold-back automatic gun clearing is provided.

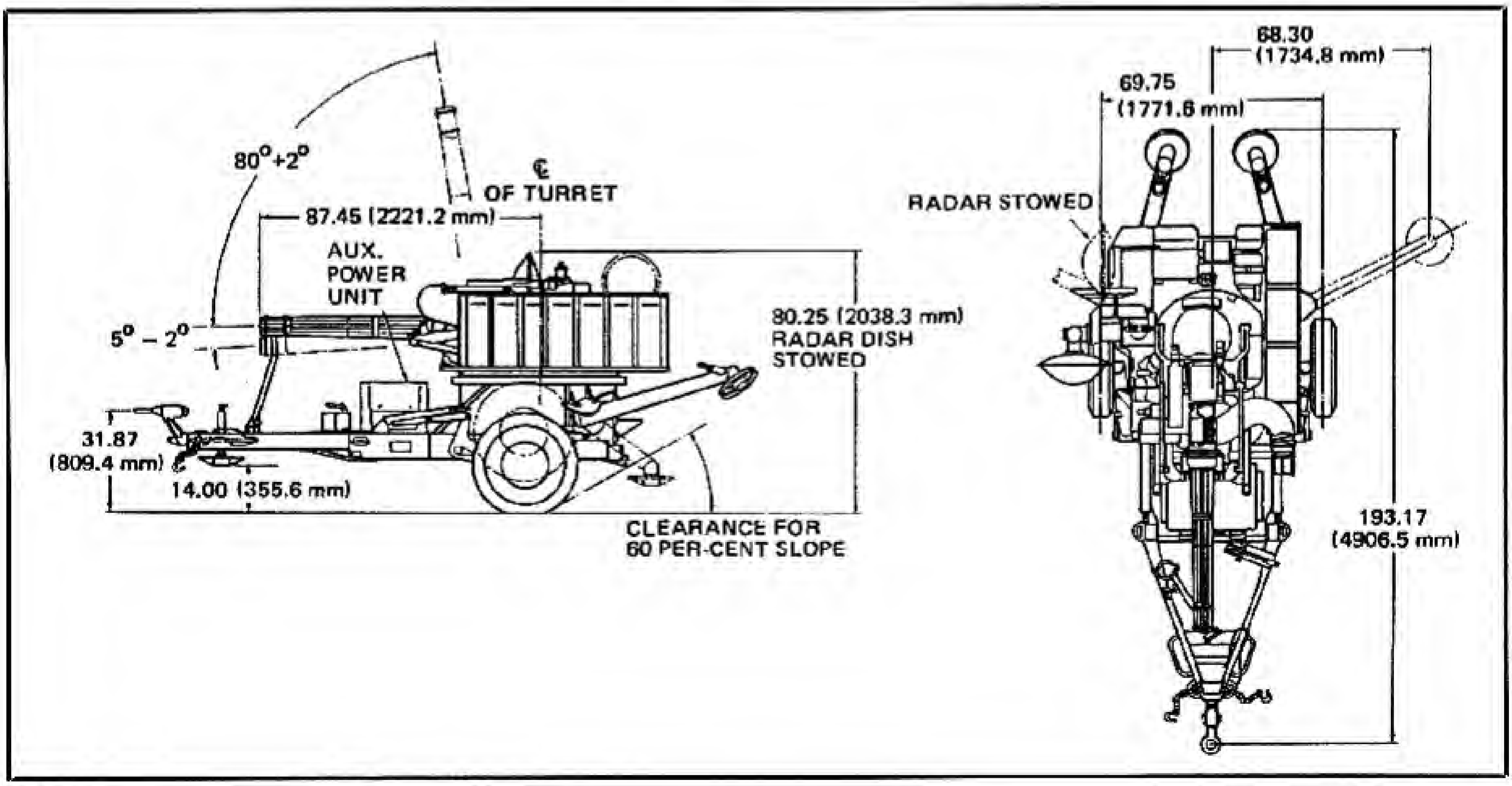
Vulcan Air Defense System M167A1. The VADS M167A1 is a lightweight, towed weapon system used against ground targets and low flying aircraft. It is air-transportable and can be dropped by cargo aircraft or helicopter. This system uses the M168 Vulcan Gun 20mm, which is the same as the M61A1 except for some system specialty components like muzzle clamps for controlled dispersion. General Electric began production deliveries in 1967.

This system is a man operated turret with a gyro lead-computing gunsight with a range only radar. The gun fires at 3000 spm with an option for 1000 spm.

Batteries drive the gun and the turret, and they are charged by an auxiliary power unit.

The gun is on the elevation axis. A linked ammunition storage container is on the azimuth axis.

The linked ammunition feed system has a hanging loop storage container in fire hose fashion. Five hundred rounds are carried in the container which sits on the left side of the top carriage (azimuth). The



M-167

M167A1 Characteristics

Weight (Combat Loaded)	3450 lbs.
Height:	
Traveling Position	80.25 in.
Emplaced	65 in.
Length:	
Traveling Position	193.17 in.
Emplaced	166 in.
Wheel Track	69 in.
Ammunition Capacity	500 rds.
Feed System	Linked, hanging rail type
Drive System	Electric
Power Requirements	On-board batteries and APU
Ammunition	M246, M50 series, M220 practice round
Firing Rates	1000/3000 spm
Barrel Life	72,000 rds.
Weapon Coverage:	
Azimuth	360°
Elevation	+80°, -5°
Turret Slewing Rates:	
Azimuth	75°/second
Elevation	60°/second
Reliability	10,000 to 20,000 MRBS
Dispersion (80% of rds fired)	12 milliradians or 8 x 18 milliradians or 6 milliradians
Recoil Force Average:	
3000 spm	1800 lbs.
1000 spm	600 lbs.

container is hand loaded placing loop after loop of linked ammo into the rear of the container. The ammo is conveyed to the gun where it is delinked, fired and links and cases, etc., ejected from the system.

The declutching feeder provides gun clearing after each burst by stopping the flow of ammo to the gun during coast down of the gun at the end of the burst.

2. Helicopter Armament with Vulcan 20mm Guns

AH-1G (Cobra) Helicopter XM35 System. The M195 Vulcan Gun 20mm is mounted on the inboard station of the lefthand, port, wing of the AH-1G (Cobra) helicopter. This is the XM35 armament system and it went to production at General Electric in 1969.

The M195 gun is the same as the Vulcan M61A1 gun except it has short barrels, 40 inches, and different spring gradient and preload recoil adapters. It also has a special muzzle blast suppressor for protecting the skin of the helicopter.

XM-35 20mm Armament System

Ammunition is stored in two containers saddle-mounted flush to both sides of the fuselage.

A booster and flexible chuting provides the gun with linked ammunition. There are 950 rounds of M50 series ammo carried in the system. Loading is by hand, looping the linked ammo into the rear of the containers.

The gun fires up to 850 spm. The declutching feeder is used for automatic gun clearing at the end of each burst. All empty cases and duds are ejected overboard during the firing.

M-195 Characteristics

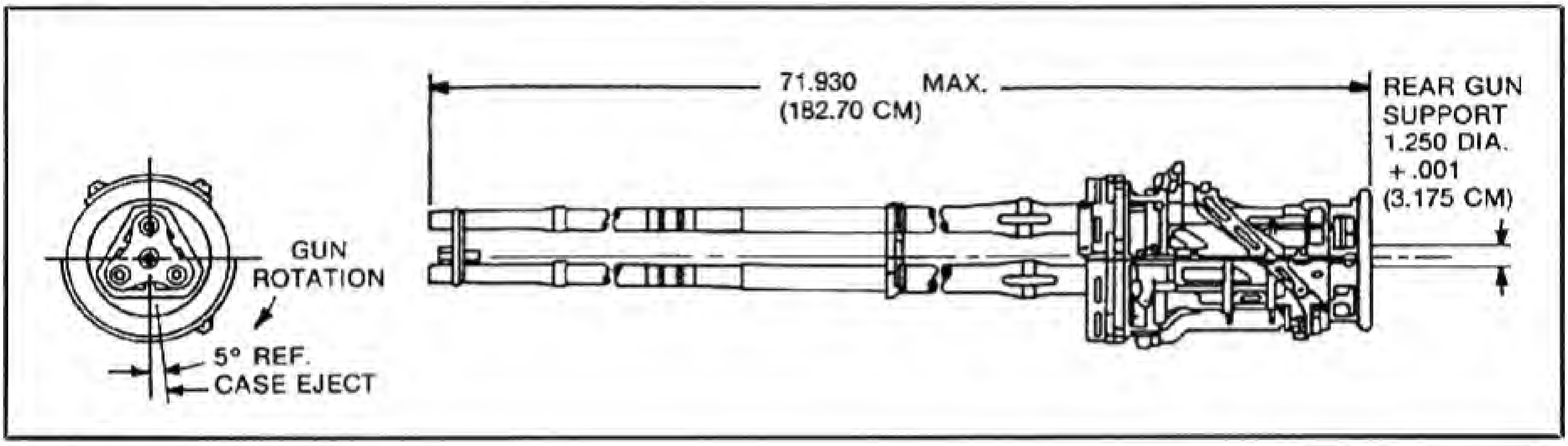
Gun	M-195 20mm Automatic Gun
Firing Rate	750 spm
Weight:	
System	535 lbs.
Ammunition (full complement)	637 lbs.
Total	1172 lbs.
Gun Life	100,000 rds.
Ammunition Capacity	950 rds.
Ammunition	M50 20mm HEI, API, HEIT, Ball Tracer or TP
Gun Drive	Electric (28 vdc)

AH-1J (Cobra) Helicopter M97 System. The M97 armament system on the nose of the AH-1J (Cobra) Helicopter is a turret that contains the M197 Vulcan Gun 20mm on its elevation function. The M197 gun is the same as the Vulcan M61A1 gun except that it has three barrels rather than six. Also, its recoil adapters are tuned to the 750 spm firing rate.

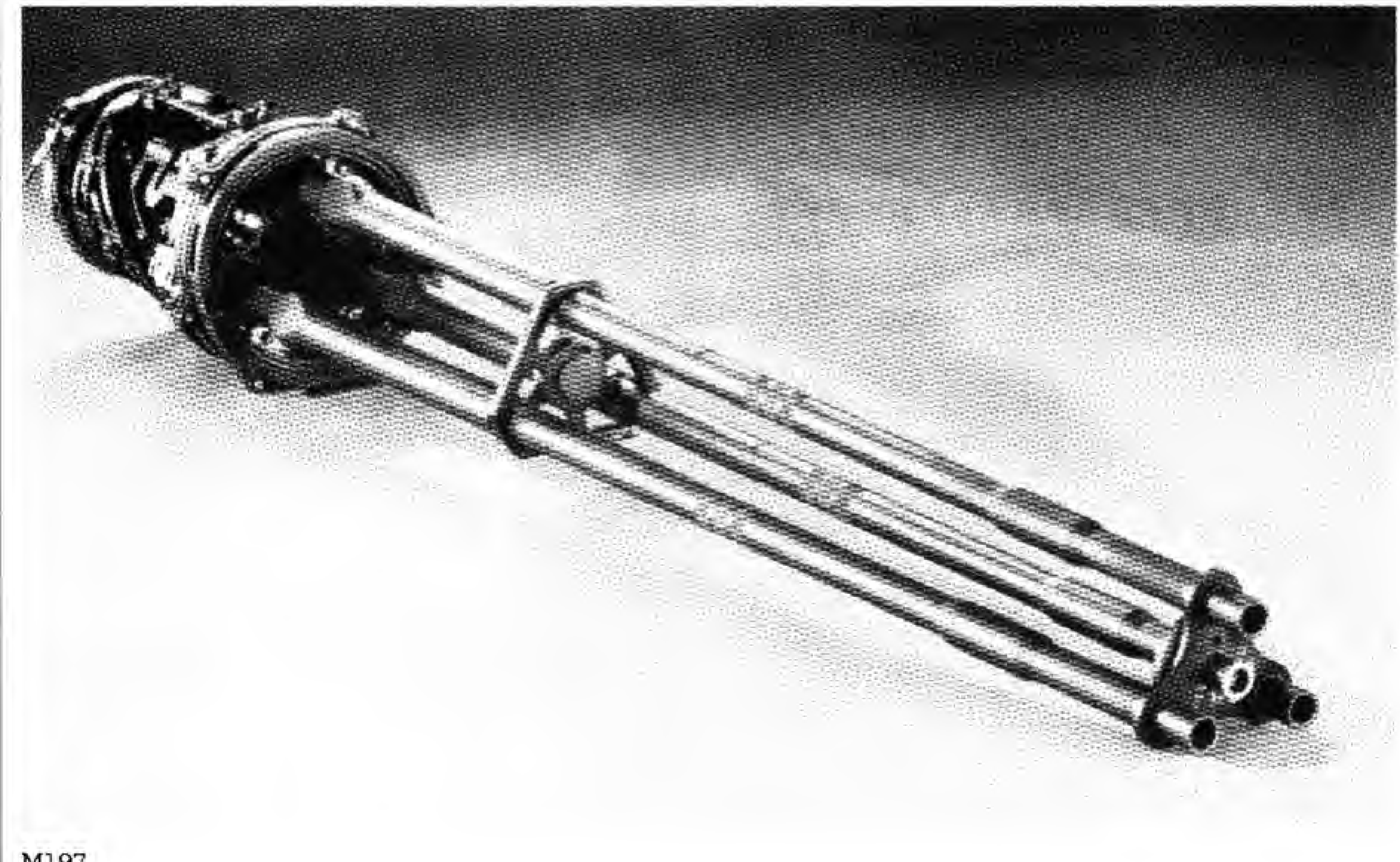
This system started in production at General Electric in 1969. Behind the turret and below the pilots and copilots seats is located the ammunition storage box. Linked ammo is used and is laid horizontally in each of the three sections of the box. The ammo folds on top of other folds with hinged short shelves supporting the projectiles to keep the linked belt level in each of the three sections. The ammo belts in each section are connected to each other forming a single belt of 750 rounds of M50 series ammo. Cross-overs at each section allow the belt to be extracted without difficulty by the booster and conveyed to the gun.

The delinking feeder strips the links and feeds the

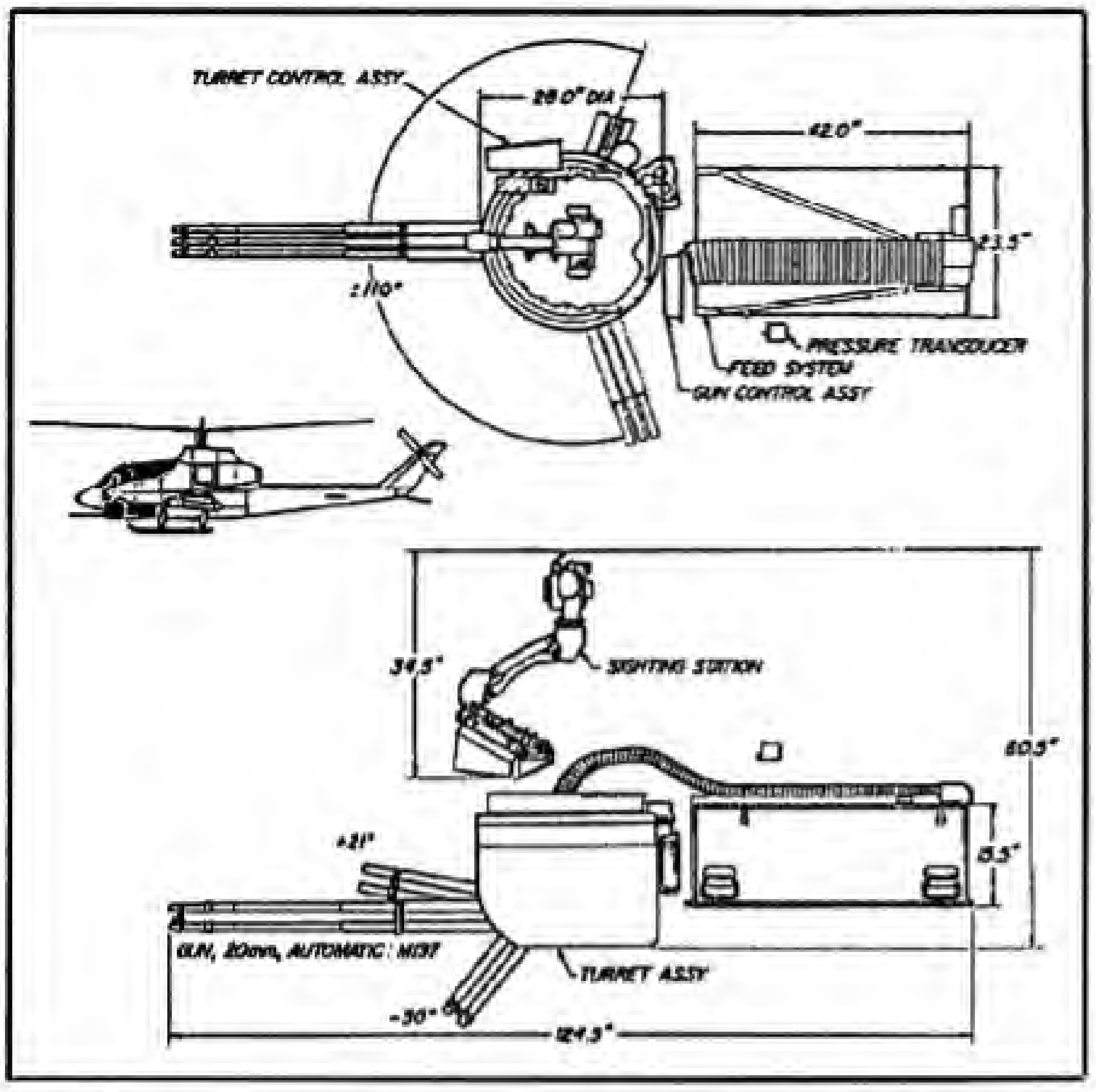
AH-1S


71.930 MAX.
(182.70 CM)
REAR GUN SUPPORT
1.250 DIA.
+.001
(3.175 CM)
GUN ROTATION
5° REF.
CASE EJECT

M197



M197


TURRET CONTROL ASSY
28.0" DIA
42.0"
23.5"
±110°
PRESSURE TRANSDUCER
FEED SYSTEM
GUN CONTROL ASSY
34.5"
SIGHTING STATION
60.5"
+21°
13.5"
GUN, 20mm, AUTOMATIC : M197
TURRET ASSY
-50°
124.5"

M197

ammo to the gun for firing. Links, empty caes and duds are ejected overboard from the gun with sufficient velocity to eliminate any danger of damage to the aircraft.

The ammo box is loaded by hand on the ground. It slides out of the port side and is supported by the slide during loading.

This same armament system has been applied to the OV-10 aircraft. The turret is located beneath the aircraft underneath the cargo area. The ammo storage container is inside the cargo bay.

M197 Characteristics

Gun	M197 20mm
Weight:	
Loaded	585.9 lbs.
Empty	417.4 lbs.
Firing Rate	750/1500 spm
Ammunition Capacity	300 rds.
Feed System	Linkless, single-ended
Drive System	Electric
Power Requirements	MIL 704 Cat. B
Battery Charger and Heater	7/15 Amps 28 vdc
Rate Selector	0.20 Amps 28 vdc
Master Arm	0.20 Amps 28 vdc
Trigger	0.20 Amps 28 vdc
Remote Clear	0.20 Amps 28 vdc
Ammunition	M50 series 20mm
Reliability	8,000 MRBS
Scheduled Maintenance	15,000 rds.
System Life	100,000 rds.
Maximum Burst Length	Full complement
Dispersion	5 mil radius, 80% circle
Case Ejection	Bottom of pod
Boresight Provisions	+2° AZ & EL @ forward lug
Recoil Loads at Gun to Mating Point:	
1500 spm Steady State	400 + 1900 lbs.
1500 spm Peak Spike	4000 lbs.
750 spm Steady State	400 + 1900 lbs.
750 spm Peak Spike	4000 lbs.
Moment of Inertia:	
Pitch	419, 931 lb. in.^{2}loaded 348,055 lb. in.^{2}empty
Yaw	407,723 lb. in.^{2}loaded 347,154 lb. in.^{2}empty
Roll	34,304 lb. in.^{2}loaded 15,750 lb. in.^{2}empty

OV-10

Pods with the Vulcan GAU-4/A and with the Vulcan M197

GPU-2/A 20mm Gun Pod. The U.S. Air Force GPU-2/A gun pod is a lightweight, self-contained gun system requiring only a trigger signal from the aircraft. It can be mounted and carried on a wide variety of helicopters and fixed wing aircraft.

The Vulcan M197 20mm gun is used. This is the three barrel, lightweight version of the Vulcan M61A1 20mm gun.

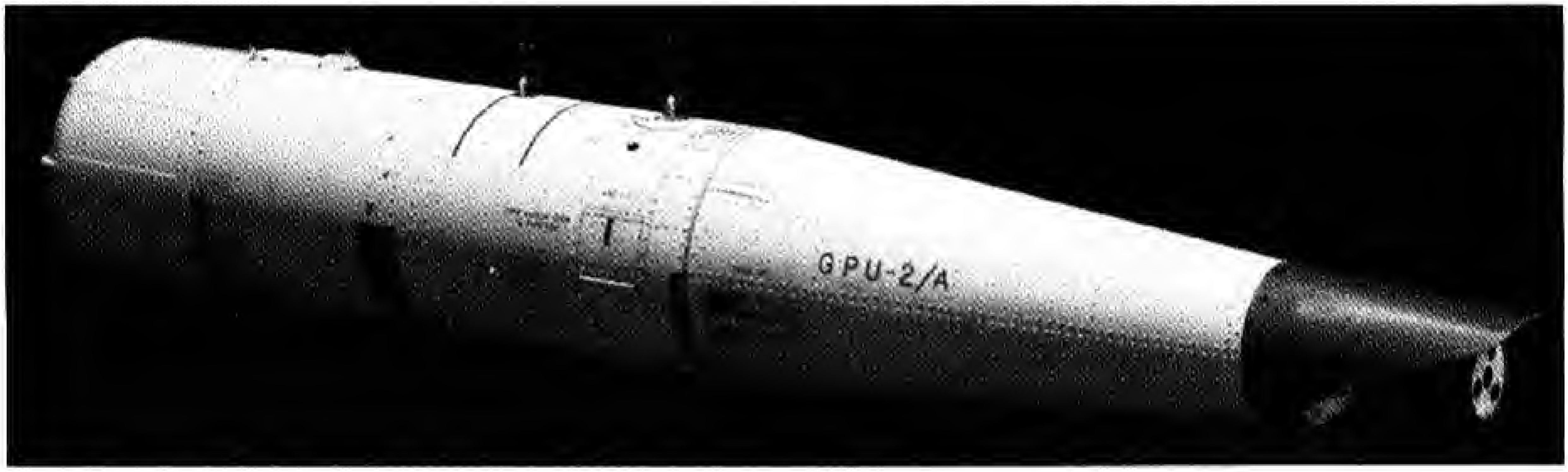
The GPU-2/A pod started in production at General Electric in 1972. A single-ended Linkless Feed System is used and contains 300 rounds of 20mm M50 series ammunition. The ammo is delivered to the gun through a gear driven conveyor wheel. No conveyor chuting or elements are used. This is the same conveyor wheel developed for the SUU-11/A minigun pod.

This pod can be loaded with ammunition while suspended from the aircraft. The forward end of the storage drum is made accessible for loading linked ammo. The drum is disconnected from the conveyor wheel and rotated backwards by a handcrank to accomplish back-loading. The links are stripped and discarded from the pod.

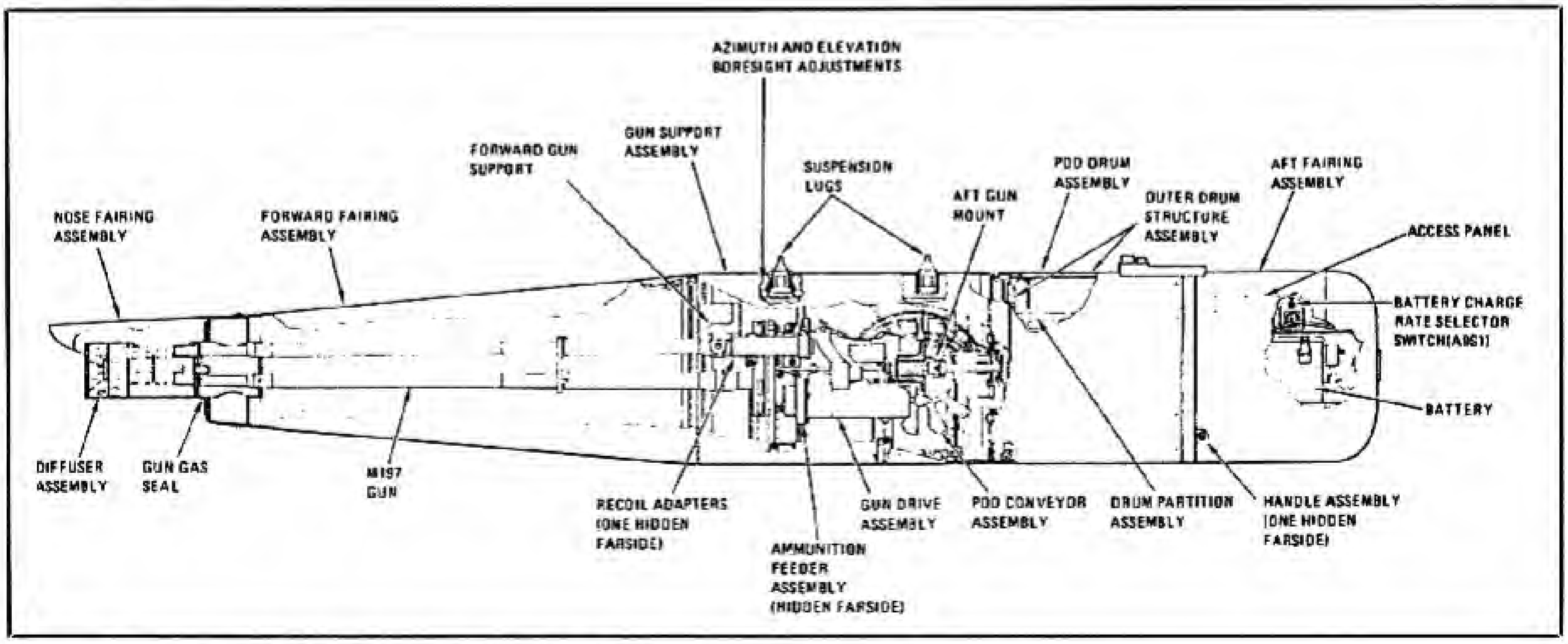
The Vulcan M197 gun fires the ammo at either 750 spm or 1500 spm as determined by the pilot. Spent cases and duds are ejected overboard.

The gun is cleared automatically at the end of each burst by a solenoid controlled clutch located at the output of the storage drum. This clutch stops the drum and allows the gun to fire out all ammo before stopping.

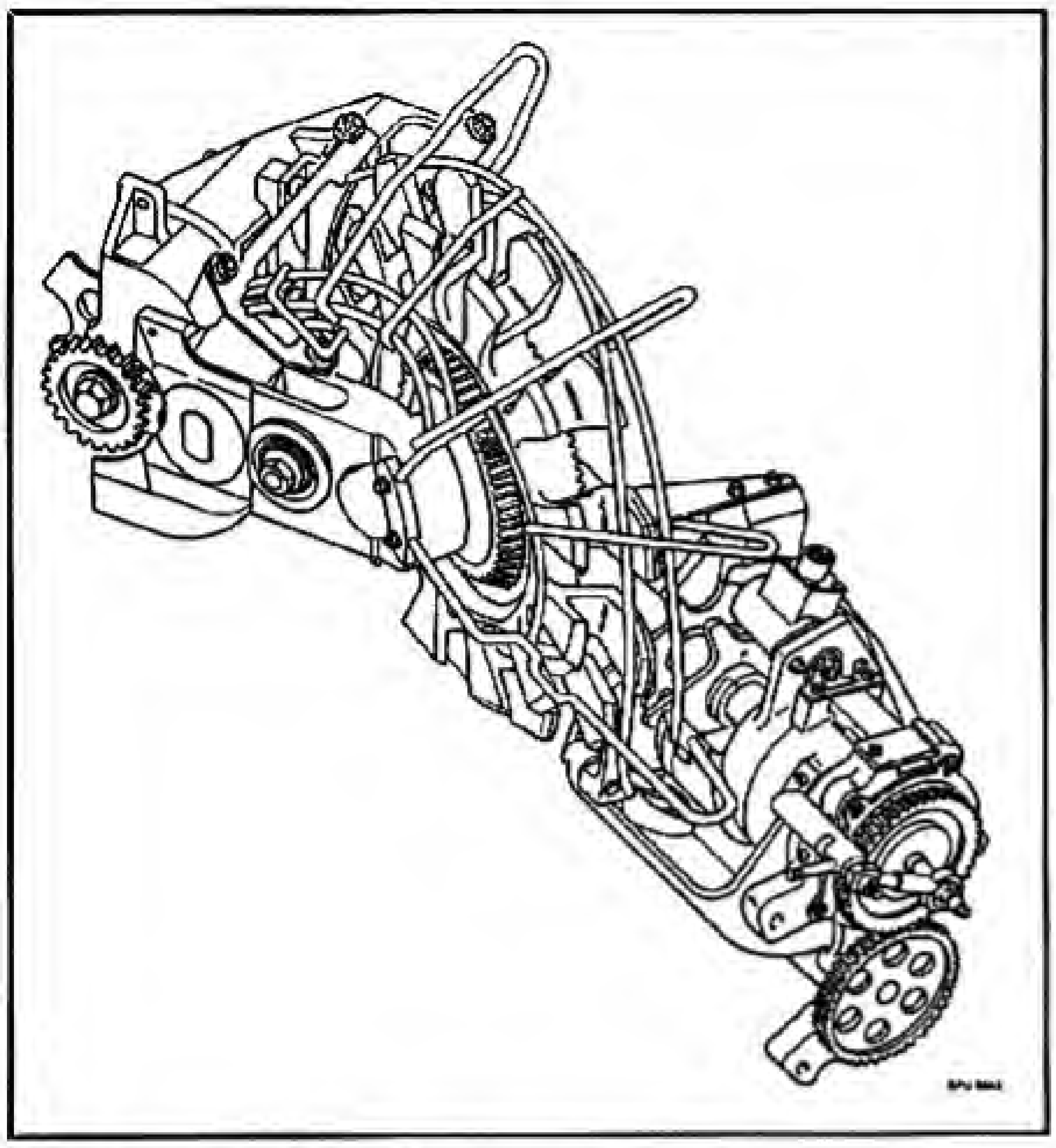
SUU-23/A Gun Pod - 20mm. The SUU-23/A Vulcan gun pod was designed and built for the U.S. Air Force by General Electric. Production started in 1966.



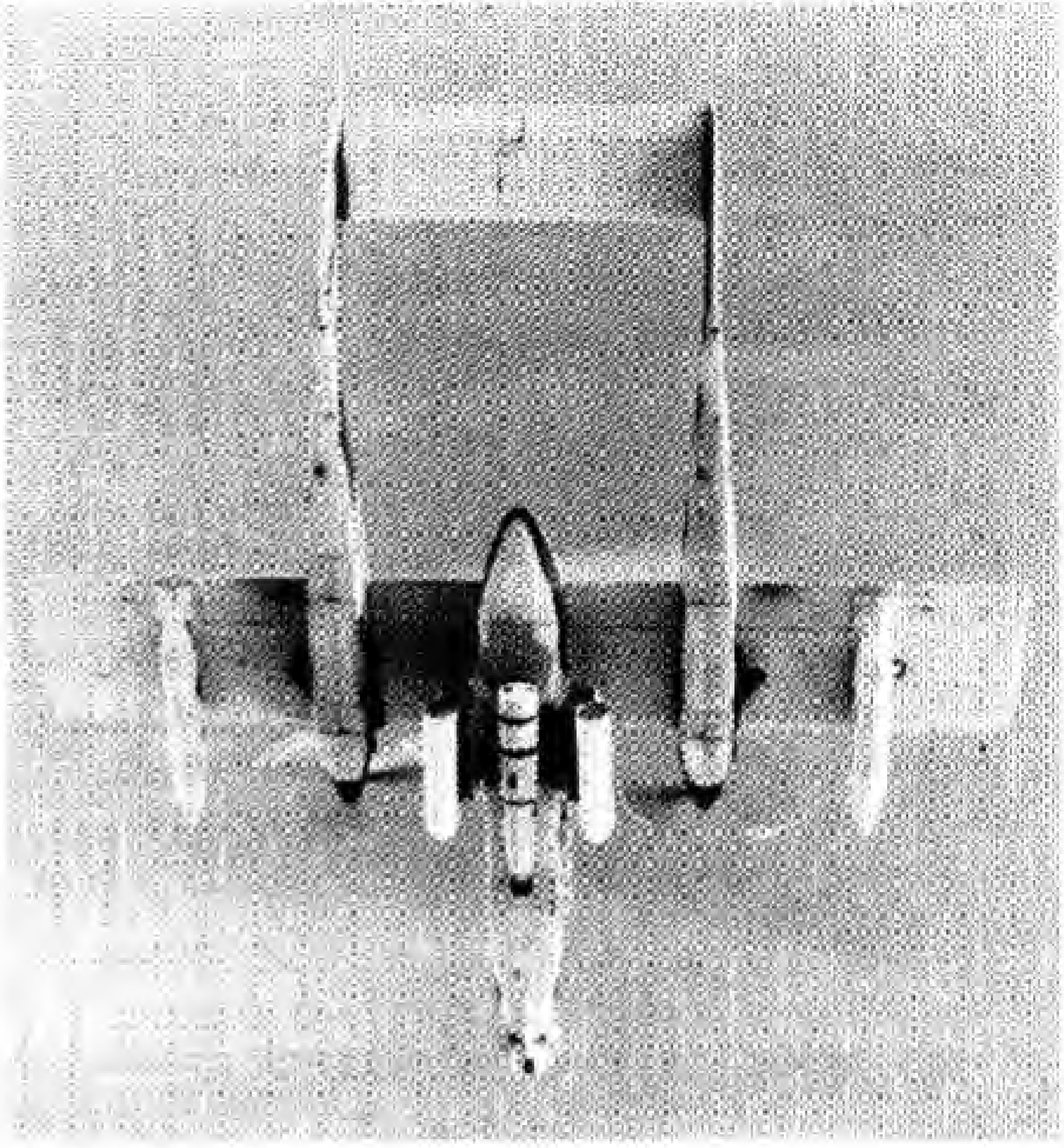
GPU-2/A Gun Pod


AZIMUTH AND ELEVATION BORESIGHT ADJUSTMENTS
FORWARD GUN SUPPORT
GUN SUPPORT ASSEMBLY
SUSPENSION LUGS
AFT GUN MOUNT
POD DRUM ASSEMBLY
OUTER DRUM STRUCTURE ASSEMBLY
AFT FAIRING ASSEMBLY
NOSE FAIRING ASSEMBLY
FORWARD FAIRING ASSEMBLY
ACCESS PANEL
BATTERY CHARGE RATE SELECTOR SWITCH(A6S1)
BATTERY
DIFFUSER ASSEMBLY
GUN GAS SEAL
M197 GUN
RECOIL ADAPTERS (ONE HIDDEN FARSIDE)
AMMUNITION FEEDER ASSEMBLY (HIDDEN FARSIDE)
GUN DRIVE ASSEMBLY
POD CONVEYOR ASSEMBLY
DRUM PARTITION ASSEMBLY
HANDLE ASSEMBLY (ONE HIDDEN FARSIDE)

General Arrangement and Structural Details of Pod



Pod Conveyor Assembly

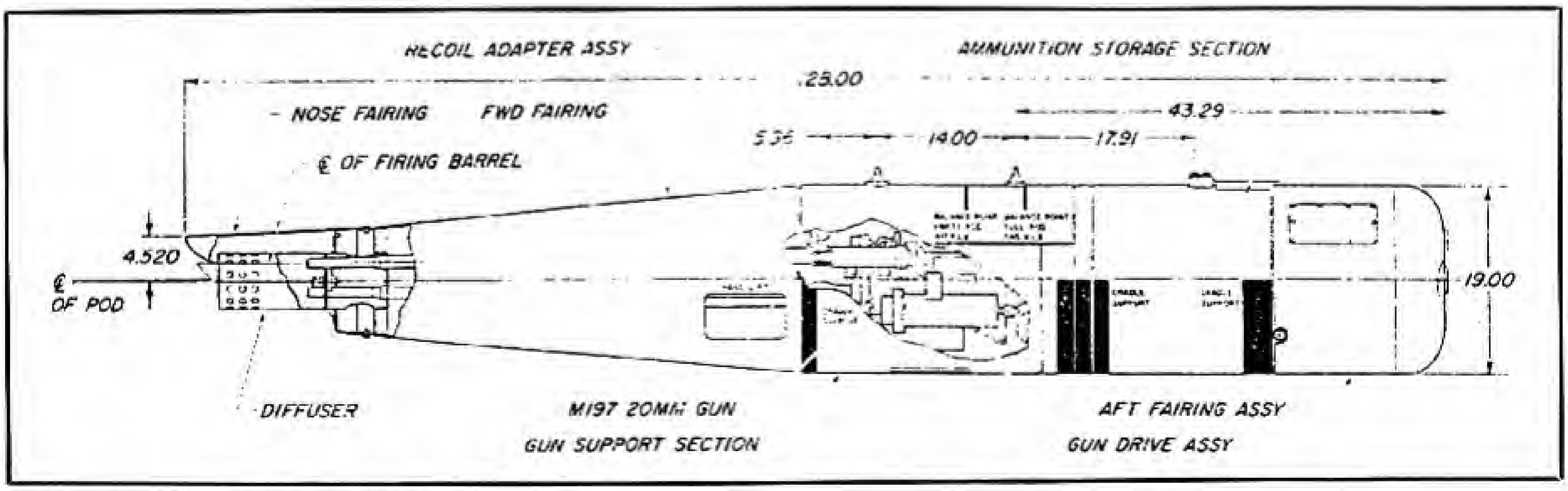


YOV-10D with GPU-2/A Pod

The pod uses a gas driven gun, the GAU-4/A, which is the same as the Vulcan M61A1 20mm gun except for the gas drive components. In the GAU-4/A gun, four of the weapon's six barrels have gas orifices drilled in them, two with forward hole and two with rear holes. Propellant gas is passed to a piston (double-acting) located inside the cylinder that is between the barrel cluster and turns with the cluster. A cam is attached to the piston and prevented from turning with the barrels since it is fixed to the gun housing via a special end plate in the back of the gun.

A single cam follower is attached to the barrel cluster and turns with the cluster. The follower is activated by the reciprocating cam resulting in a rotational force to the cam which in turn rotates the barrel cluster and causes the gun to fire and to sustain this drive action until the electrically primed ammo is prevented from firing.

Initial barrel rotation is provided by an electrically-driven inertia wheel starter. After accelerating the weapon, the starter disengages itself automatically, as the weapon fires and continues to accelerate itself to 6000 spm.

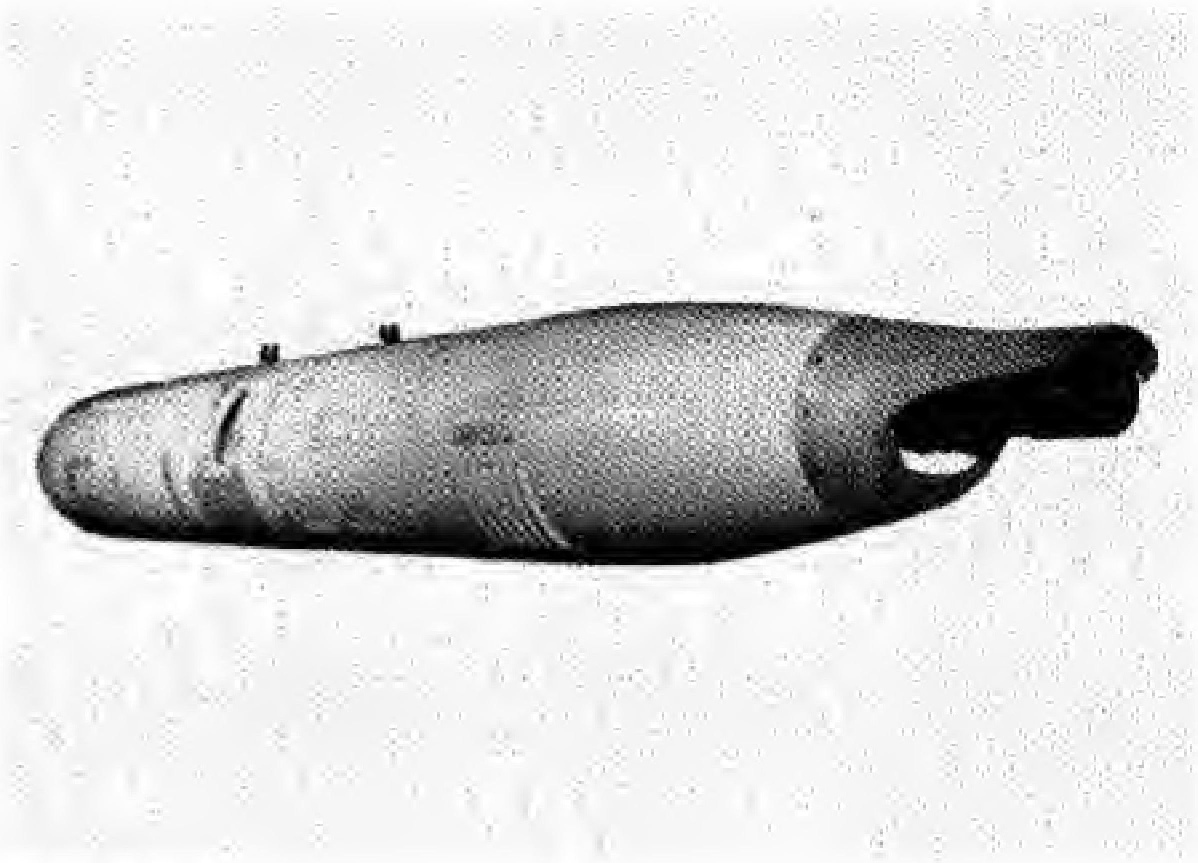

RECOIL ADAPTER ASSY
AMMUNITION STORAGE SECTION
25.00
NOSE FAIRING
FWD FAIRING
43.29
5.36
14.00
17.91
℄ OF FIRING BARREL
4.520
℄ OF POD
19.00
DIFFUSER
M197 20MM GUN
GUN SUPPORT SECTION
AFT FAIRING ASSY
GUN DRIVE ASSY

GPU-2/A Pod using the M197 Gun.

The gun is cleared after each burst using the automatic hold-back clearing sector.

A single-ended Linkless Feed System is used holding 1200 rounds of M50 series ammo. The gun ejects the empty cases, duds and cleared rounds overboard.

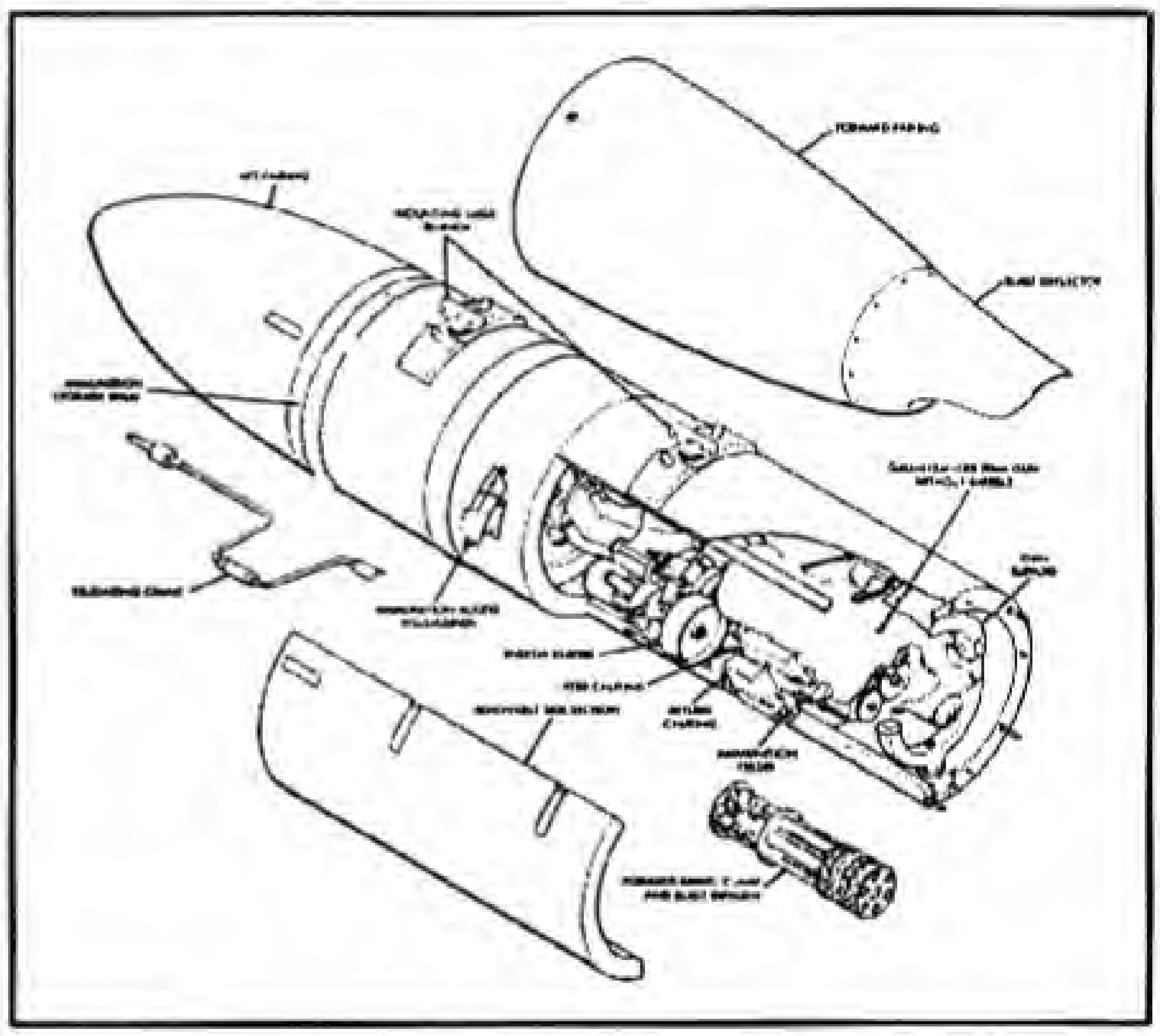
The storage drum is back-loaded with linked ammo by using a handcrank and disconnecting the drum gearing. The links are stripped and discarded beneath the pod.



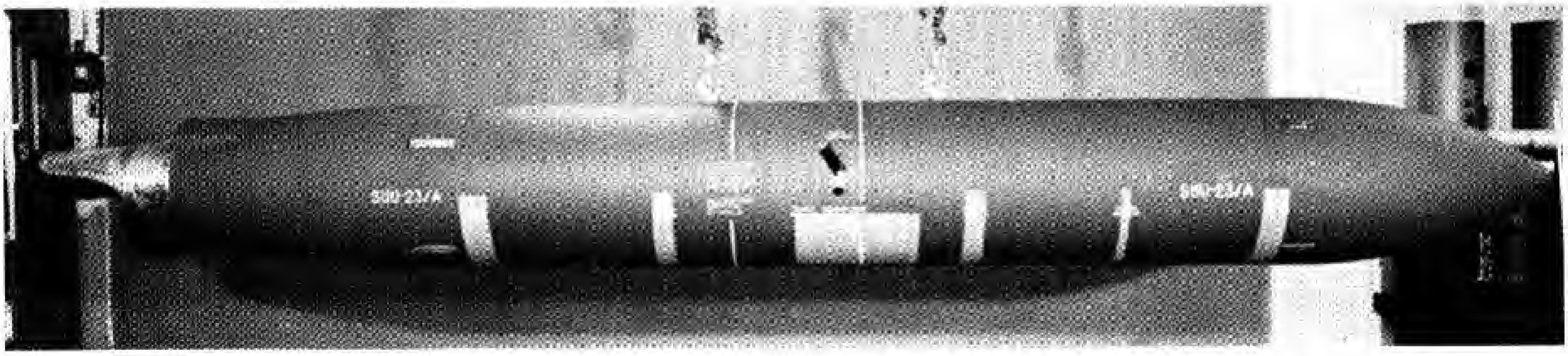
SUU-23/A

GAU-4 Characteristics

Gun	GAU-4, 20mm
Drive System	Gun Gas Operated
Drive Power Input	About 40 HP
Electrical Power From Aircraft	208 vac, 400 cycle, 3 phase, 10 amps
Firing Rate	6000 spm
Ammunition Capacity	1200 rds.
Pod Length	197 ins.
Pod Diameter	22 ins.
Pod Weight:	
With Ammunition	1720 lbs.
Without Ammunition	1045 lbs.
Attachment to Aircraft	30 in. Lugs, per MIL-A-8591; Compatible with Century Series Aircraft
Center of Gravity Shift when Ammunition is Expended	17 ins. Forward
Maximum Burst Length	Full Complement
Ammunition Cook-off Hazard	None with Automatic Clearing



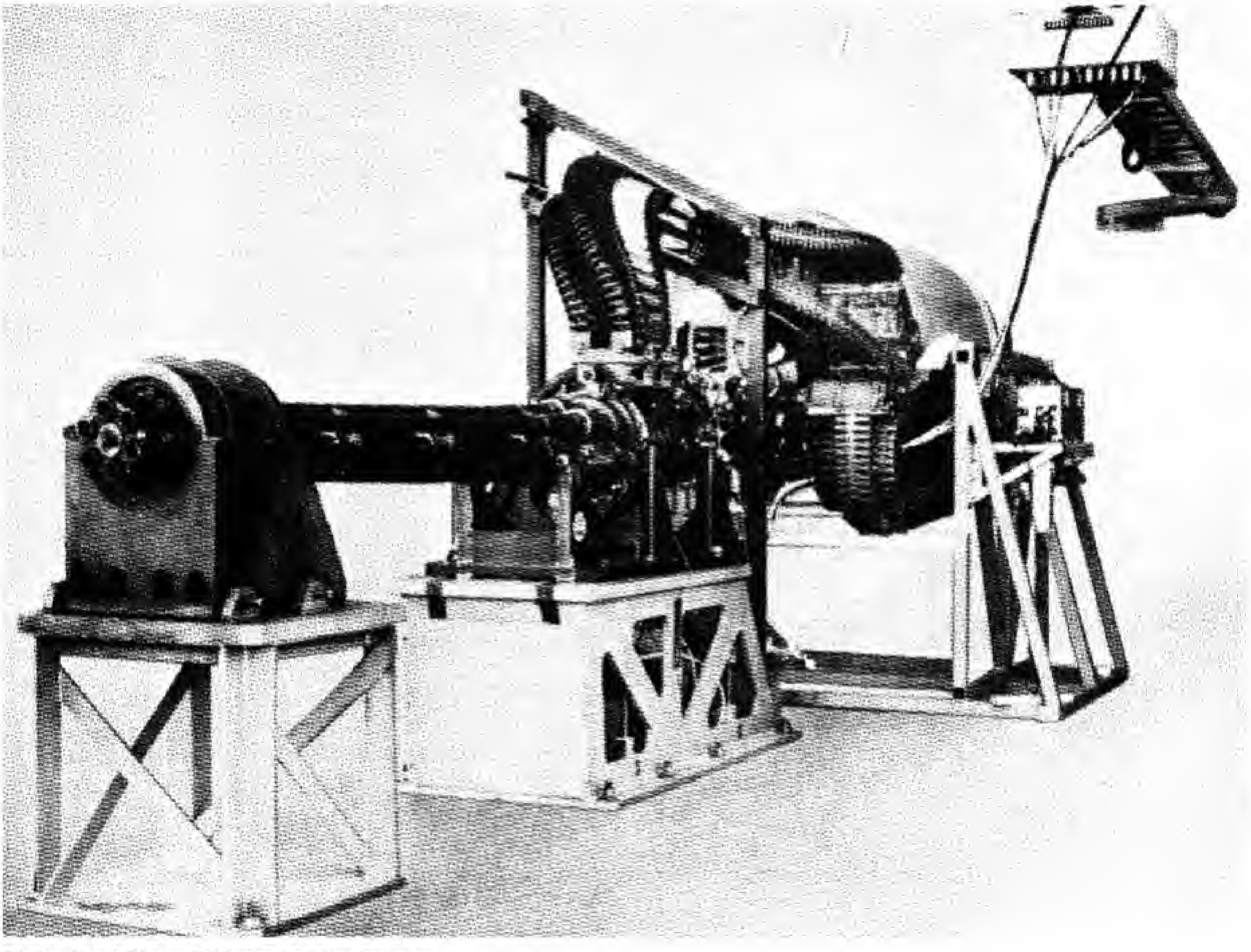
GAU-4



SUU-23/A

30mm GAU-8/A CLOSE AIR SUPPORT WEAPON

PHILCO-FORD CORPORATION (Prototype)

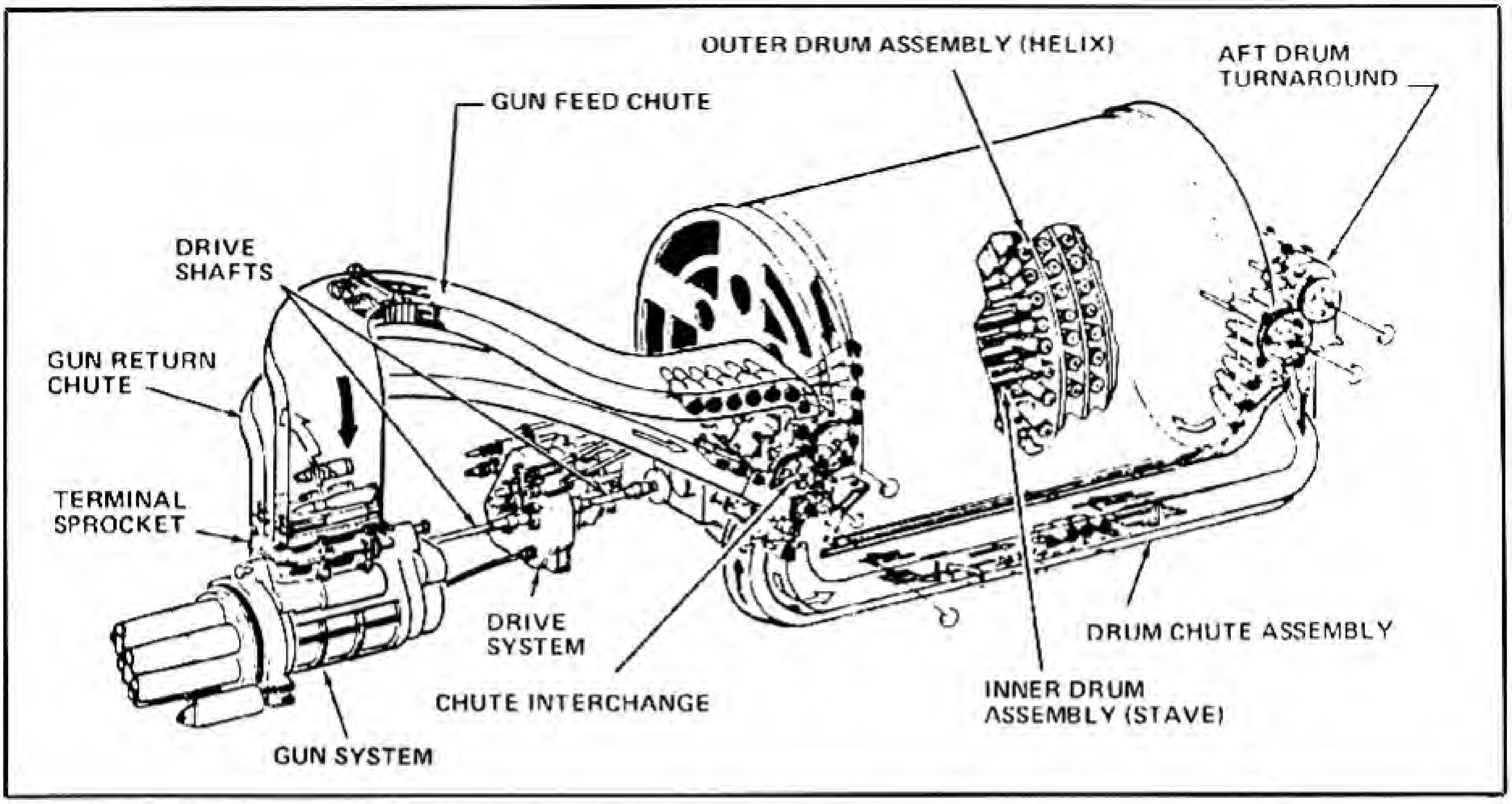


Philco-Ford Phase I GAU-8/A Gun System

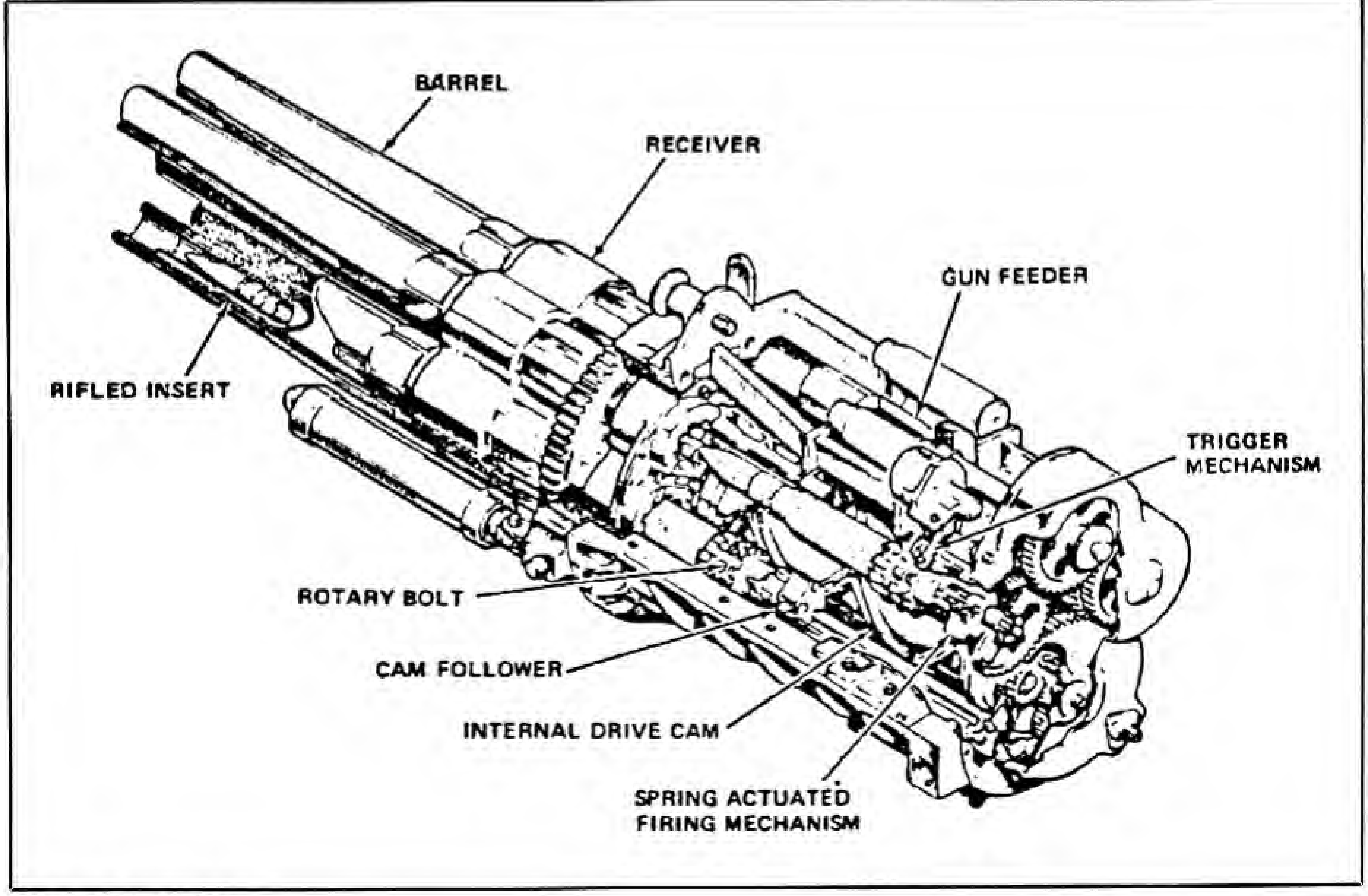
History

The history of the Philco-Ford GAU-8/A 30mm Close Air Support Weapon Prototype began with development of the A-10 aircraft requirement and ended in mid 1973 when this gun lost in a competiton with General Electric's GAU-8/A Prototype.

Philco-Ford built three prototype weapons, Emerson Electric was responsible for the feed system and Honeywell developed the ammunition. The cost of the development contract was about $12.1 million


OUTER DRUM ASSEMBLY (HELIX)
AFT DRUM TURNAROUND
GUN FEED CHUTE
DRIVE SHAFTS
GUN RETURN CHUTE
TERMINAL SPROCKET
DRIVE SYSTEM
DRUM CHUTE ASSEMBLY
CHUTE INTERCHANGE
INNER DRUM ASSEMBLY (STAVE)
GUN SYSTEM

Philco-Ford GAU-8/A Weapon System Configuration


BARREL
RECEIVER
GUN FEEDER
RIFLED INSERT
TRIGGER MECHANISM
ROTARY BOLT
CAM FOLLOWER
INTERNAL DRIVE CAM
SPRING ACTUATED FIRING MECHANISM

GAU-8/A Phase I Gun

dollars. The contract was let in 1971 and the final report delivered June 1973.

All of the work was monitored by the Air Force Armament Laboratory, Eglin Air Force Base, Florida.

A total of three guns and about 100,000 rounds of ammunition were manufactured.

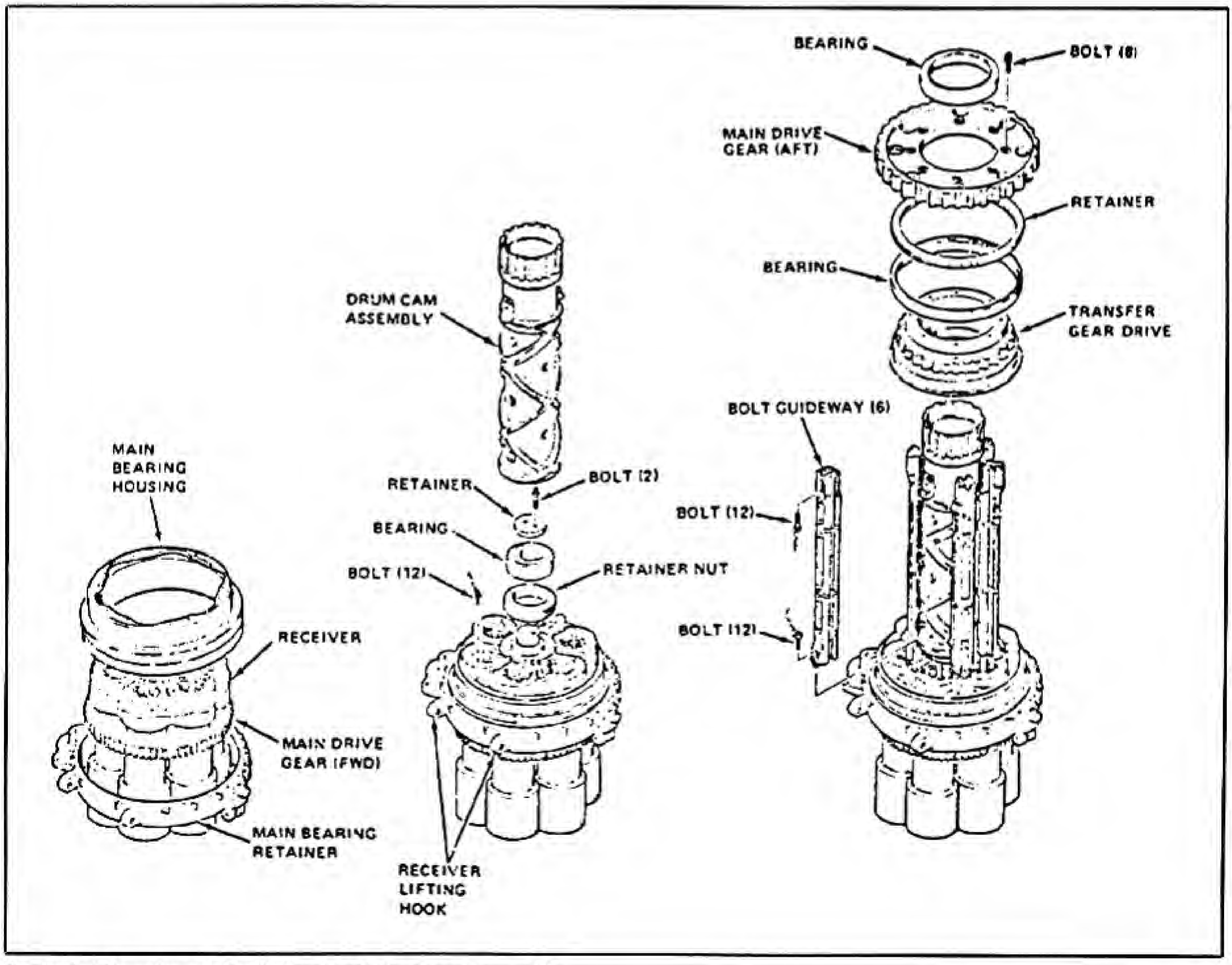
Description and Purpose

The Philco-Ford GAU-8/A Prototype is a 30mm six chamber rotary gun with a linkless feed system identical with the GE developed Galley five system. The power is provided by two hydraulic motors. The gun is 112 inches long, 16.0 inches wide, 18.0 inches high and weighs 581 pounds with feeder and recoil adapters. The total system is 220 inches long, 39.5 inches wide and 41.0 inches high. The system weighs about 1,575 pounds empty and less than 3,500 pounds when loaded with 1,350 rounds of ammunition.

An interesting feature of this gun is that the barrels are smooth bore and have a 10" long rifled insert locked into the barrel at the breech end. The barrels are 84 inches long and weigh about 37.5 pounds each. The barrels are locked to the breech with a 90 degree twist and are supported by a muzzle clamp and a mid-barrel clamp.

The gun system includes the gun and drive subsystems, a feed and storage system, and a control system. The last contains an electronic control unit, a reload pendant, a rounds totalizer and the electrical cable assemblies.

The ammunition for this gun is percussion primed, has an aluminum case and the projectiles have plastic rotating bands. The muzzle velocity is 3,500 feet per second.


BEARING
BOLT (8)
MAIN DRIVE GEAR (AFT)
RETAINER
BEARING
TRANSFER GEAR DRIVE
DRUM CAM ASSEMBLY
BOLT GUIDEWAY (6)
MAIN BEARING HOUSING
RETAINER
BOLT (2)
BOLT (12)
BEARING
BOLT (12)
RETAINER NUT
BOLT (12)
RECEIVER
MAIN DRIVE GEAR (FWD)
MAIN BEARING RETAINER
RECEIVER LIFTING HOOK

Exploded Drawing of the Philco-Ford Receiver Assembly

Characteristics

Bore Size	30mm
Muzzle Velocity	3200-3500 fps
Rate of Fire	4000/2000 rpm
Locking System	External Mechanism
Feed System	Sprocket Type
Method of Chambering	Ram
Weapon by Source	United States Air Force
Manufacturer	Philco-Ford
Ammunition	Percussion Primed
Overall:	
Length	112 in.
Width	16 in.
Height	18 in.
Weight (with feeder and recoil adapters)	581 lb.
Barrel:	
Length	84 in.
Weight	37.5 lbs.
Twist	90"

The purpose of this gun was to provide the primary armament of the United States Air Force A-10 aircraft.

Cycle of Operation

The Philco-Ford gun receives rounds from the feed system terminal sprocket and depending on the command condition of the trigger the gun either chambers and fires the rounds and returns spent cases to the terminal sprocket, or, during gun clearing, bypasses rounds through the gun housings and returns them to the terminal sprocket without ramming or chambering them. At the end of each burst, the gun reverses direction and the leading unfired round in the feed system is automatically repositioned at the terminal sprocket so that it will be placed in the first bolt to be cammed forward after reapplication of the firing command.

When the trigger is energized, the electronic control unit immediately applies power to the trigger control solenoid and simultaneously initiates rotation of the gun feed and storage systems by the drive subsystem. The leading unfired and following rounds are accelerated into the feeder housing and handed onto a rotary bolt, so that the extractor lugs on the bolt engage the extraction groove of the case. Longitudinal round control from the terminal sprocket to the bolt is provided by the feeder housing and the flange on the pickoff transfer housing.

Radial round control is maintained between the ammunition stripper and transfer buckets. The trigger control solenoid positions the trigger cam which forces each cam follower into the proper internal drum cam path.

When the bolt cam follower enters the drum cam path, the bolt and round are rammed forward into the chamber. Radial round control is provided by the fixed ammunition guide mounted to the feeder housing until the round is in the chamber. As the round is fully chambered, the cam follower is cammed out of the drum cam path into forward dwell by the cam follower extractor and the bolt is rotated and locked into the receiver by the external locking mechanism. The locking rotation of the bolt within the receiver causes the firing pin to fall and the round is fired.

As the receiver continues to rotate, the firing pin is cocked, the bolt unlocked, the firing pin resceared, and the cam follower is inserted into the appropriate drum cam path by the firing pin bolt actuator cam. As the bolt carrier is driven aft by the drum cam, the bolt follows and the spent case is extracted. The bolt and spent case continue rearward until the cam follower reaches the rear dwell portion of the drum cam path where it is cammed out of engagement by the rear cam follower extractor. The spent case is removed from the bolt by the ammunition stripper and returned to the conveyor in the terminal sprocket by the stripper and handoff transfer buckets.

This sequence continues for each barrel until the trigger is released manually or is terminated by the burst limiter in the electronic control unit. When the trigger is released, power is immediately removed from the trigger mechanism control solenoid which allows the return spring to reposition the trigger cam so that subsequent cam followers are not inserted into the drum cam path.

When the trigger reaches the clearing position, a micro-switch is energized and a command to advance seven additional rounds are given automatically to the drive subsystem by the electronic control unit. This assures that all six of the bolts are in the rear dwell position before reversing the gun to clear unfired rounds from the receiver. A remote sensor in the feed system electro-mechanically memorizes where the next round was located at the instant the trigger cam was fully retracted. After advancing seven rounds from this position, the system is stopped and reversed until the leading unfired round has been returned to the position where it will be the first to be fired in the subsequent burst.

The rotation of the stave assembly drives the live rounds toward the forward end of the drum where they are scooped from the drum helix by the handoff sprocket. The rounds are placed in the empty conveyor elements of the forward loop by the forward interchange. They travel through the feed flex chute to the terminal sprocket where they enter the gun and are fired. The spent cases are handed off to the terminal sprocket and carried to the forward interchange by the return chute where they are transferred to the aft loop. The rear loop carries the cases to the aft turnaround which inserts them back into the drum to replace the live rounds which are moving toward the front of the drum.

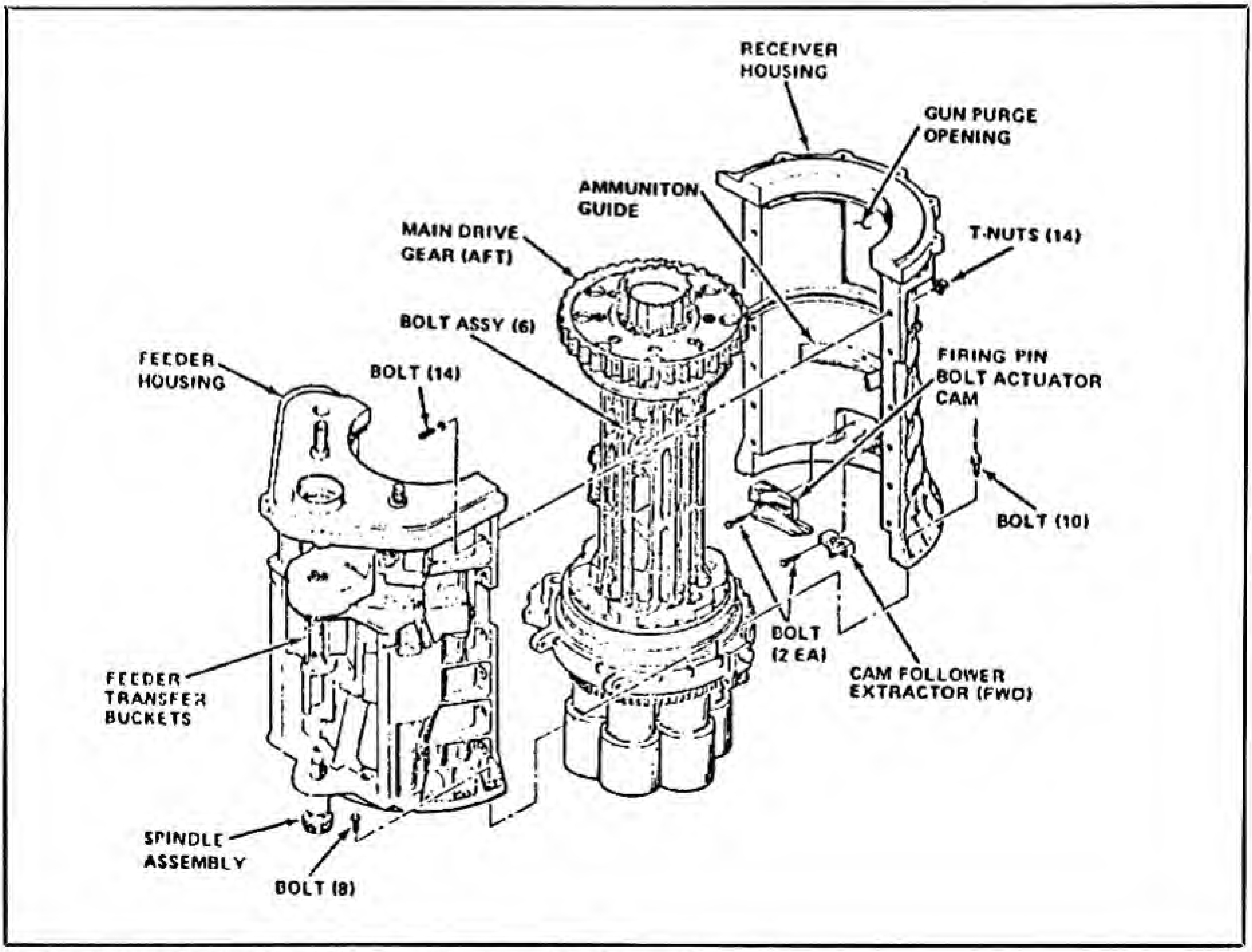
Whenever the gun is firing, the feedback circuits of the electronic control unit are monitoring system performance. Should any of the monitored components fail to perform to predetermined standards, the electronic control unit will automatically stop operation. Indicators on the electronic control unit chassis provide information on why the system stopped.

Test Results

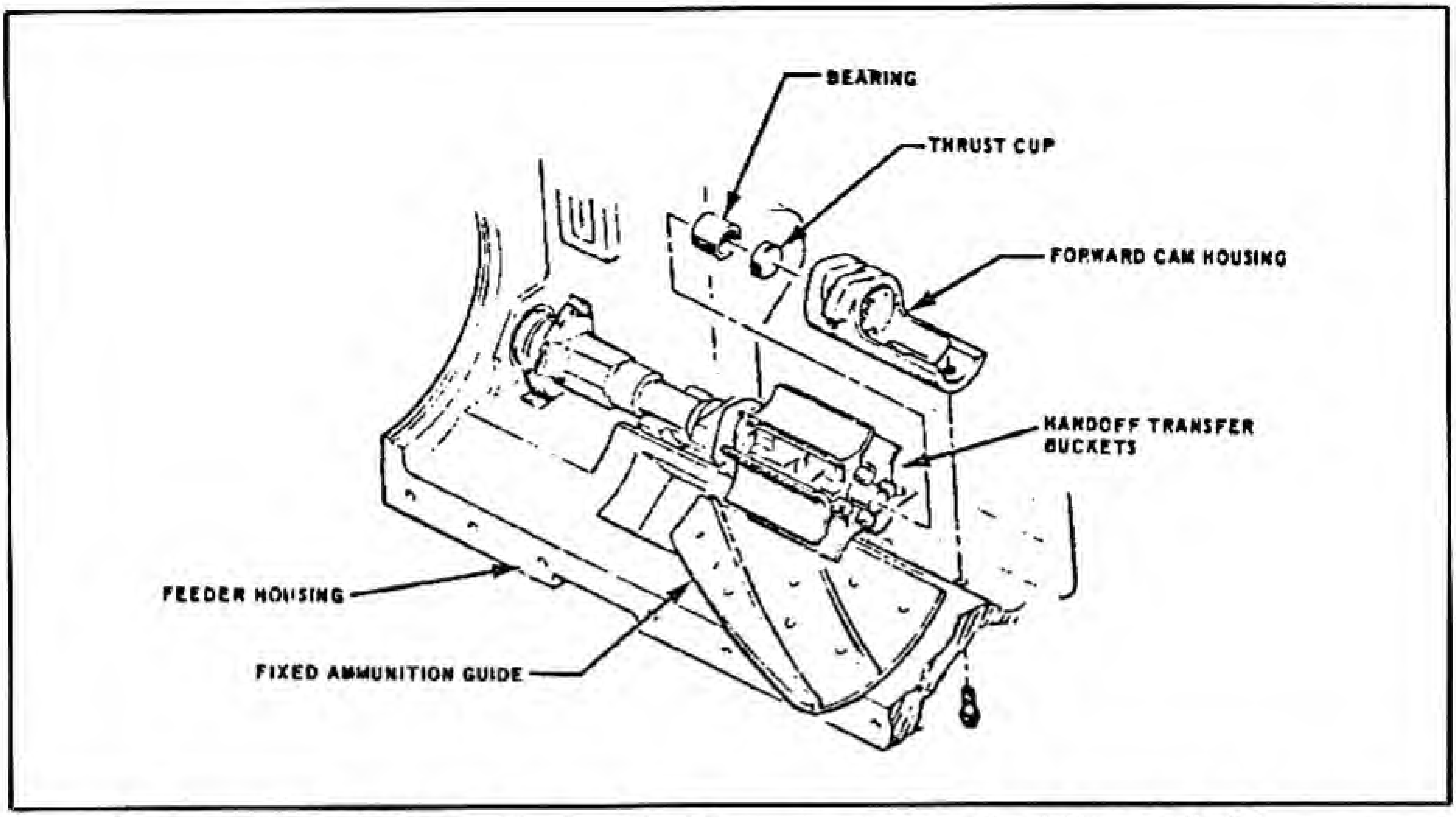
This weapon was extensively tested at Eglin Air Force Base in the first quarter of calendar 1973. Three guns were used in these tests.

The Philco-Ford GAU-8/A guns fired successfully at low (2000 rpm) and high rate (4000 rpm). The time to achieve 90 percent of the low rate ranged from 63 to 214 milliseconds. The time to achieve 90 percent of high rate ranged from 155 to 460 milliseconds. Average hydraulic horsepower delivered to the gun ranged from 27.1 to 46.9 at low rate and from 29.9 to 93.8 at high rate.

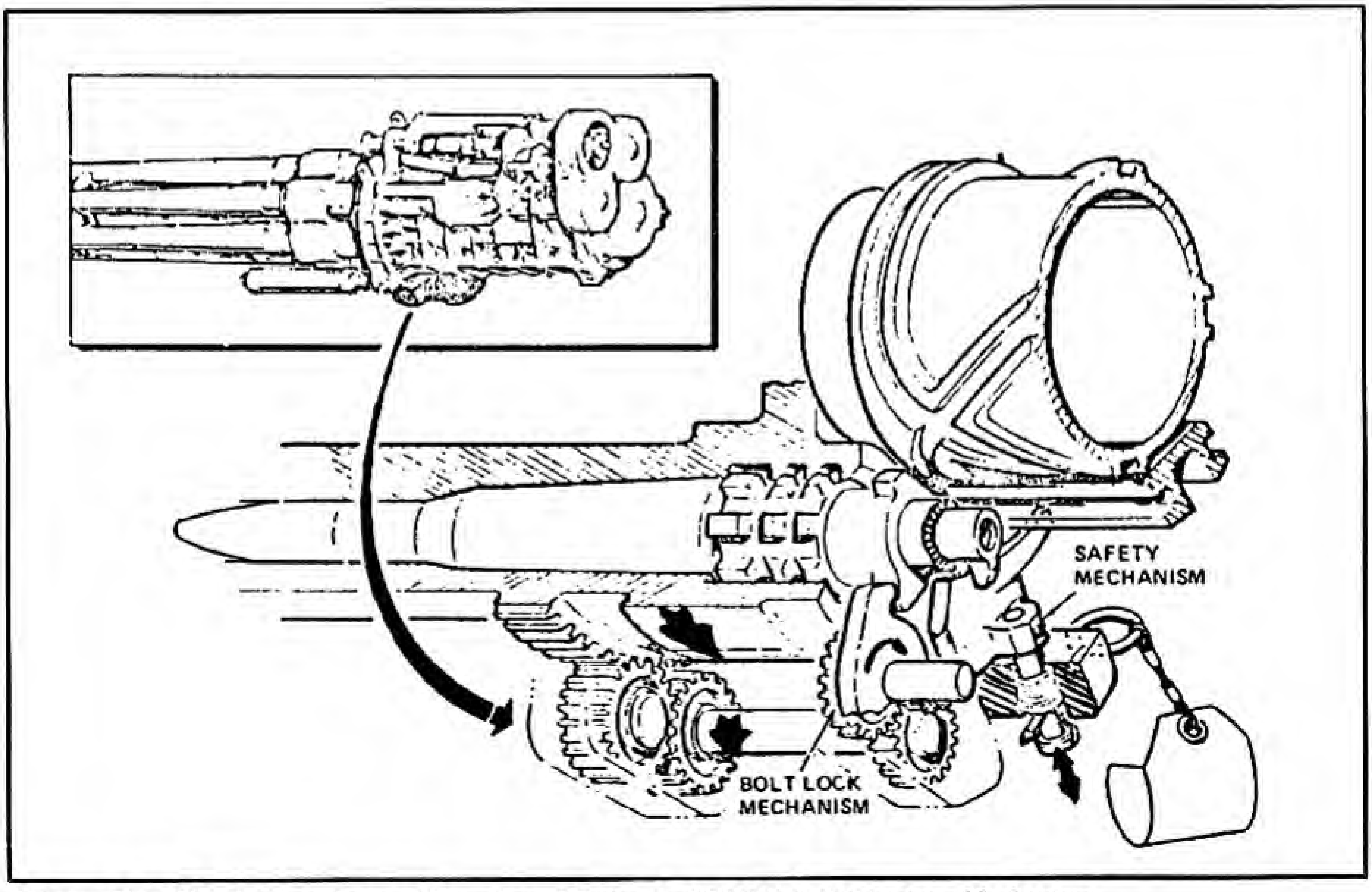
The nonchambering reverse clearing cycle of the gun with the bolts and rounds in the rear position


RECEIVER HOUSING
GUN PURGE OPENING
AMMUNITON GUIDE
T-NUTS (14)
MAIN DRIVE GEAR (AFT)
BOLT ASSY (6)
FEEDER HOUSING
BOLT (14)
FIRING PIN
BOLT ACTUATOR CAM
BOLT (10)
BOLT (2 EA)
CAM FOLLOWER EXTRACTOR (FWD)
FEEDER TRANSFER BUCKETS
SPINDLE ASSEMBLY
BOLT (8)

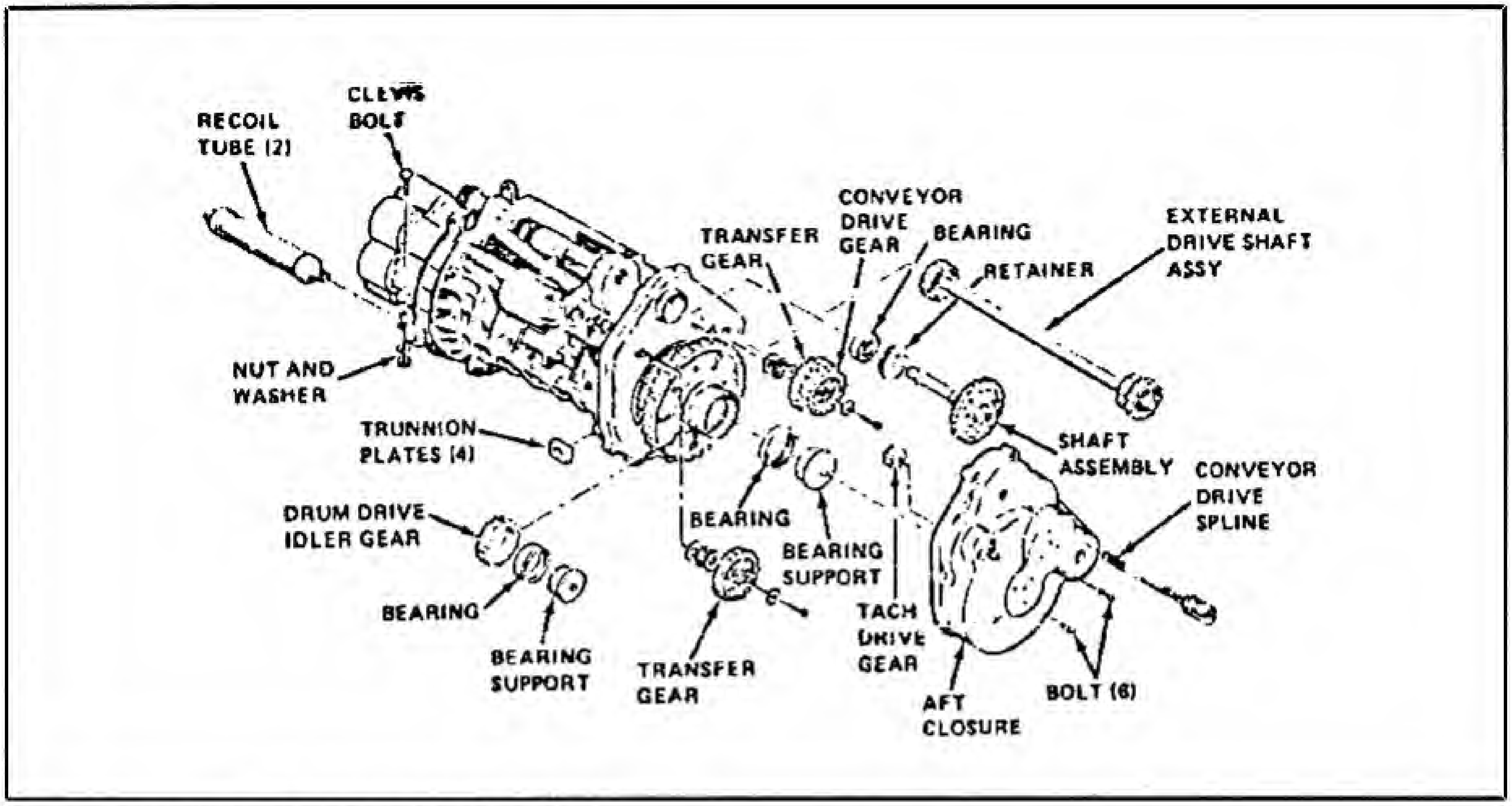
Exploded View of the Feeder and Receiver Housings of the Receiver Assembly


BEARING
THRUST CUP
FORWARD CAM HOUSING
HANDOFF TRANSFER BUCKETS
FEEDER HOUSING
FIXED AMMUNITION GUIDE

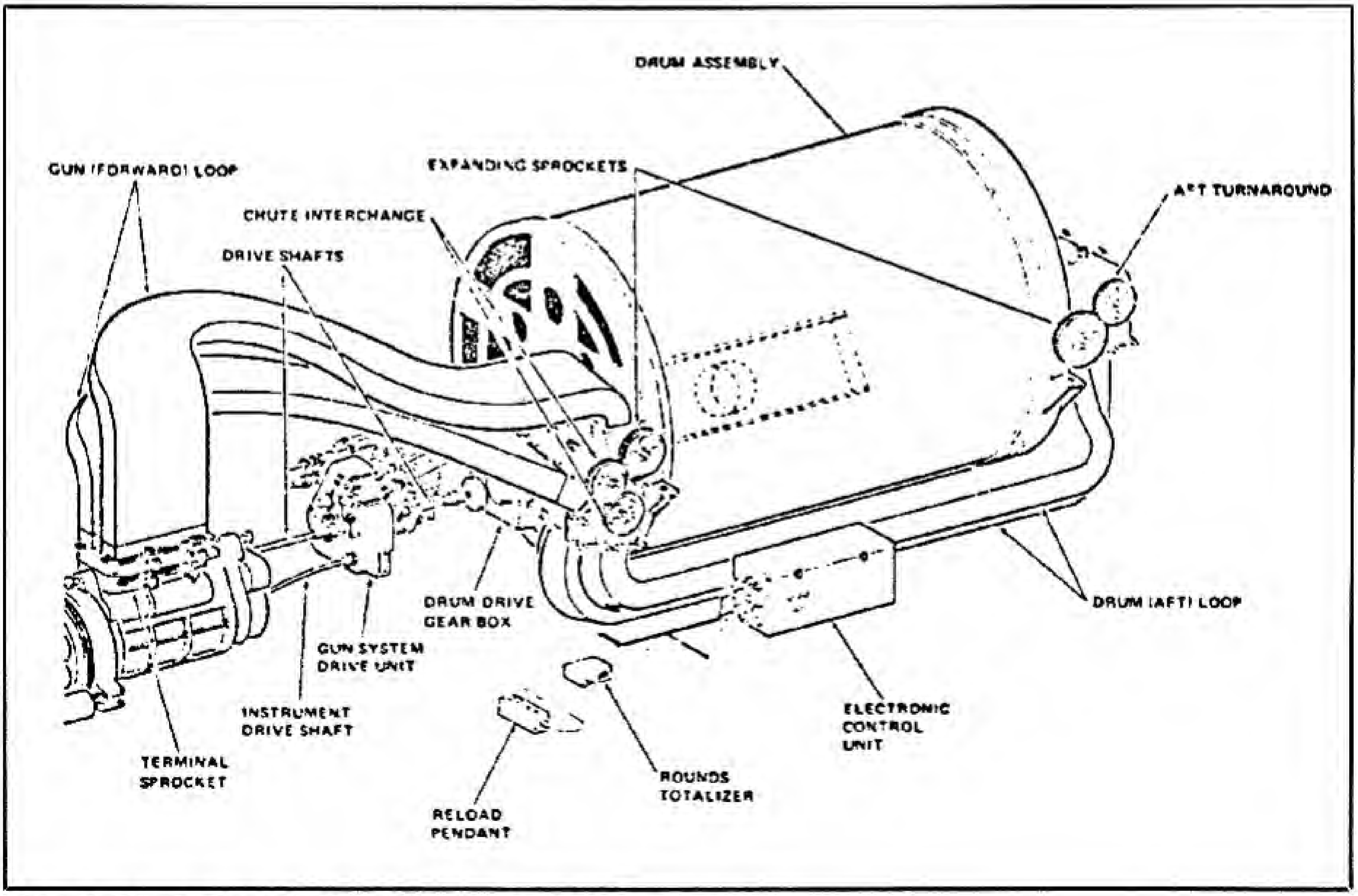
Sectioned Drawing of the Feeder Housing Showing a Fixed Ammunition guide and Handoff Transfer Buckets


SAFETY MECHANISM
BOLT LOCK MECHANISM

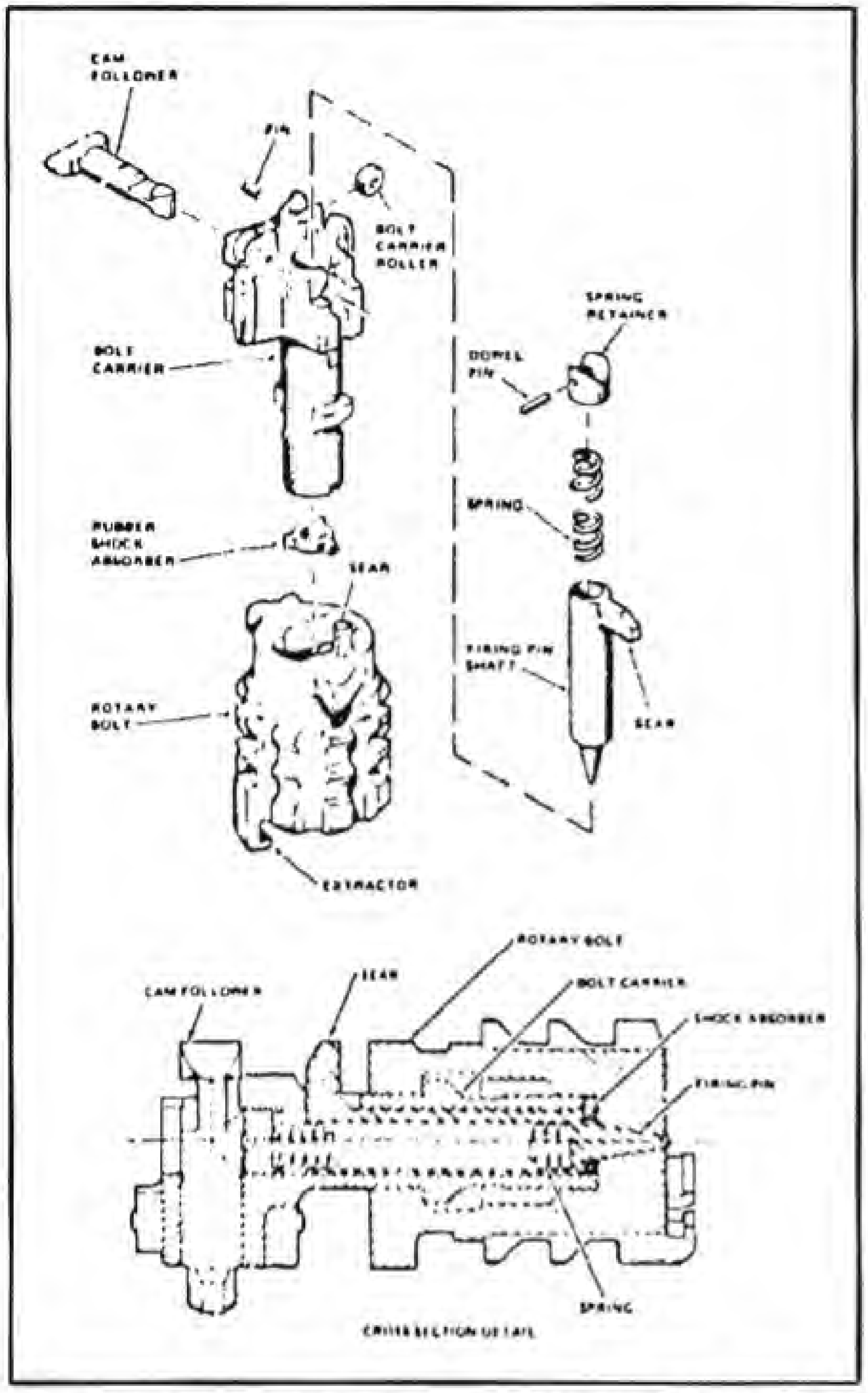
Cutaway View Showing Location and Operation of Philco-Ford GAU-8/A Bolt Locking Mechanism


CLEVIS BOLT
RECOIL TUBE (2)
CONVEYOR DRIVE GEAR
TRANSFER GEAR
BEARING
RETAINER
EXTERNAL DRIVE SHAFT ASSY
NUT AND WASHER
TRUNNION PLATES (4)
SHAFT ASSEMBLY
CONVEYOR DRIVE SPLINE
DRUM DRIVE IDLER GEAR
BEARING
BEARING SUPPORT
BEARING
TACH DRIVE GEAR
BEARING SUPPORT
TRANSFER GEAR
AFT CLOSURE
BOLT (6)

Components of Philco-Ford GAU-8/A Gear Train


DRUM ASSEMBLY
GUN (FORWARD) LOOP
EXPANDING SPROCKETS
AFT TURNAROUND
CHUTE INTERCHANGE
DRIVE SHAFTS
DRUM DRIVE GEAR BOX
DRUM (AFT) LOOP
GUN SYSTEM DRIVE UNIT
INSTRUMENT DRIVE SHAFT
ELECTRONIC CONTROL UNIT
TERMINAL SPROCKET
ROUNDS TOTALIZER
RELOAD PENDANT

Philco-Ford Feed System Showing the Forward and Aft Ammunition Loops

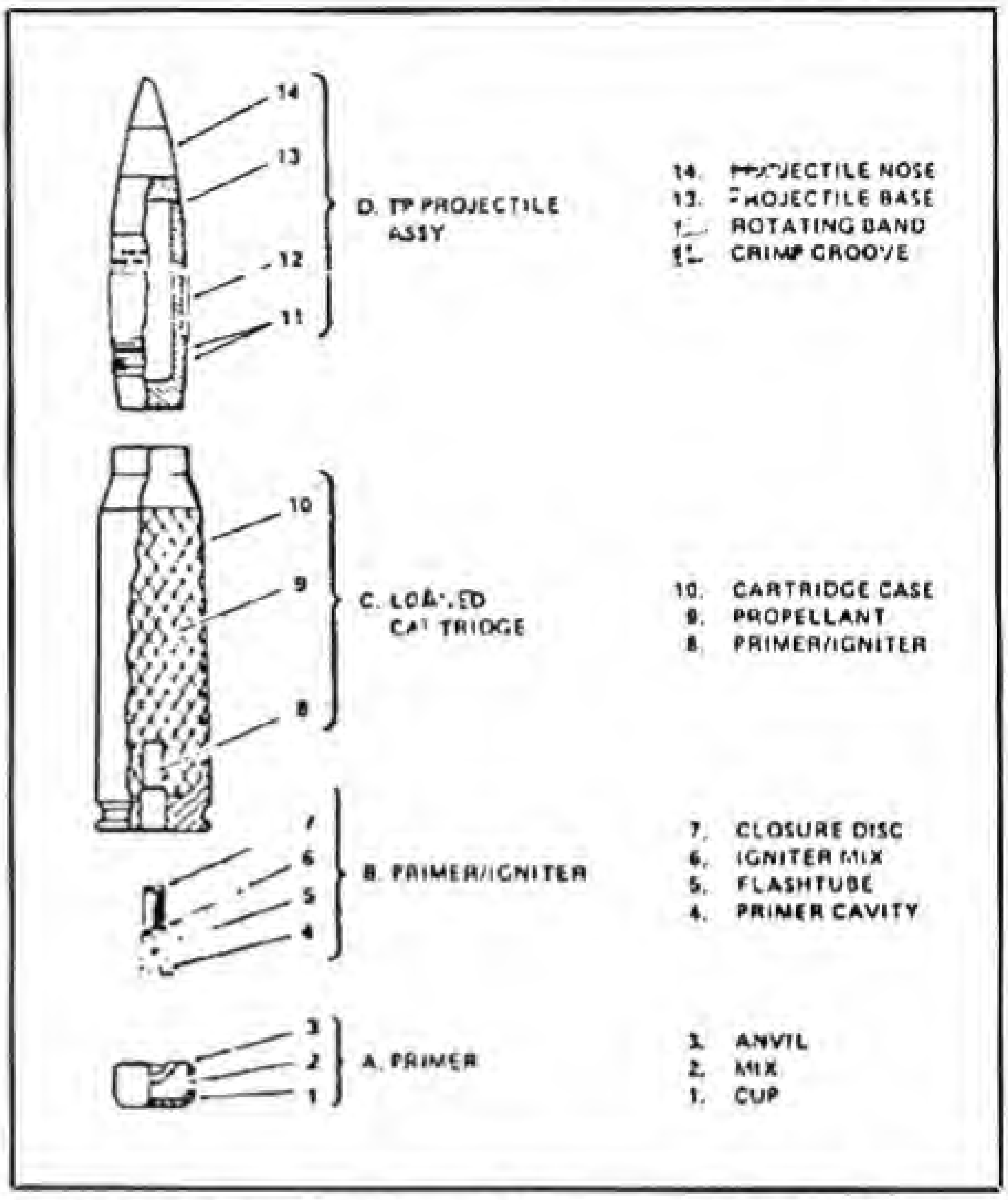

CAM FOLLOWER
PIN
BOLT CARRIER ROLLER
SPRING RETAINER
BOLT CARRIER
DOWEL PIN
SPRING
RUBBER SHOCK ABSORBER
SEAR
FIRING PIN SHAFT
ROTARY BOLT
SEAR
EXTRACTOR
ROTARY BOLT
SEAR
CAM FOLLOWER
BOLT CARRIER
SHOCK ABSORBER
FIRING PIN
SPRING
CROSS SECTION DETAIL

Assembly Drawing of the Philco-Ford GAU-8/A Rotary Bolt

operated properly during the test.

The electronic control unit shutdown features and the dual, variable displacement motors functioned properly. The two-piece gun housing made the gun very accessible during maintenance and gun safing operations.

The gun was not capable of firing a complement of ammunition, without a failure and the rifled liner inserts failed after less than 610 rounds on two occasions.


14
13
12
11
D. TP PROJECTILE ASSY
14. PROJECTILE NOSE
13. PROJECTILE BASE
12. ROTATING BAND
11. CRIMP GROOVE
10
9
8
C. LOADED CARTRIDGE
10. CARTRIDGE CASE
9. PROPELLANT
8. PRIMER/IGNITER
7
6
5
4
B. PRIMER/IGNITER
7. CLOSURE DISC
6. IGNITER MIX
5. FLASHTUBE
4. PRIMER CAVITY
3
2
1
A. PRIMER
3. ANVIL
2. MIX
1. CUP

Exploded Cutaway View of Honeywell GAU-8/A 30mm Target Practice Ammunition

The dispersion measurements ranged from 4.23 to 14.74 mils for burst lengths of 2 seconds or longer and from 4.00 to 8.66 mils for one second, high-rate bursts.

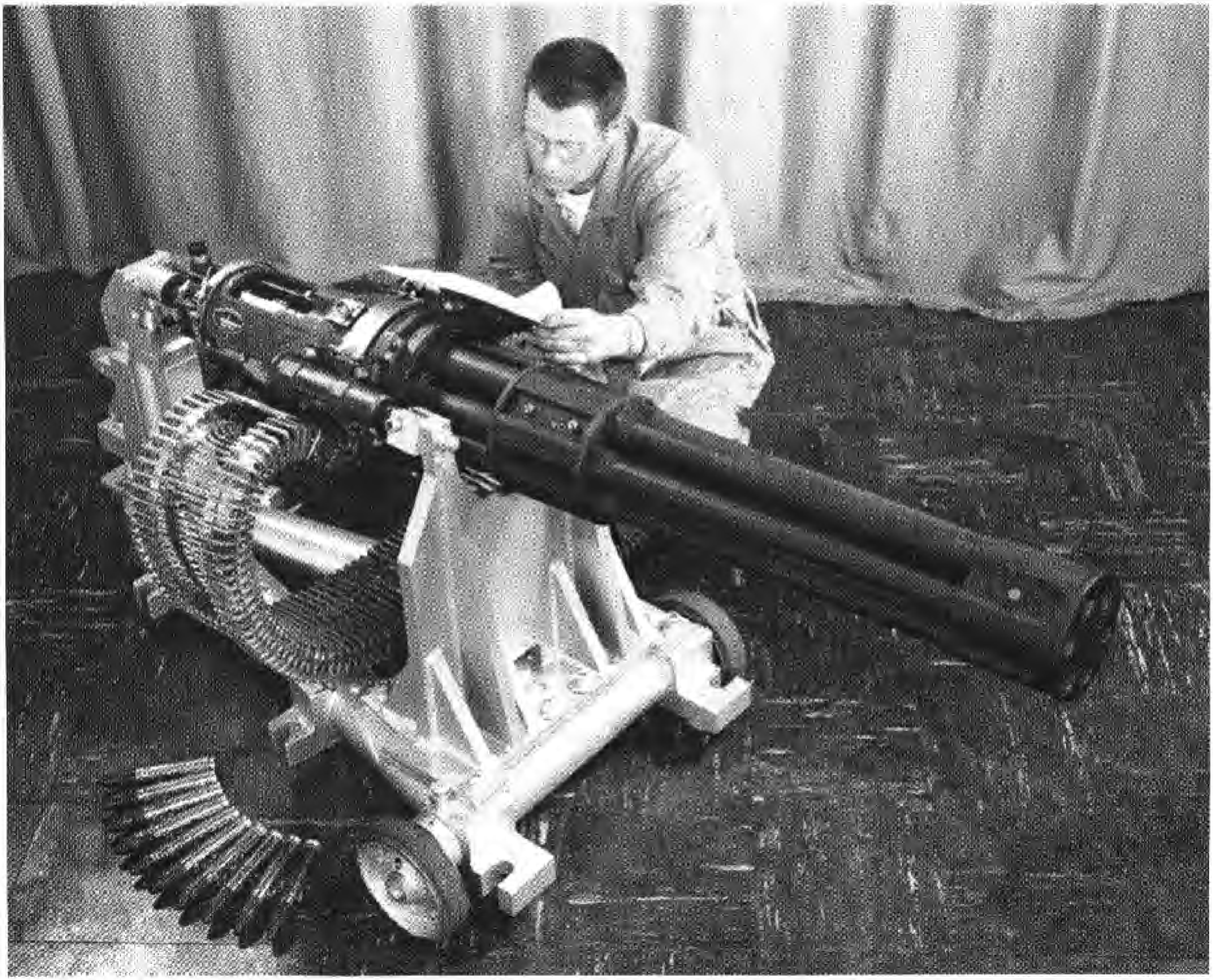
The Honeywell target practice ammunition had a tendency to debullet under ramming loads and rough gun handling and the polyurethane rotating band showed very poor retention during tests.

Philco-Ford 30mm GAU-8/A Contender. (Photo courtesy of Woodin Laboratories.)

Chapter 3

30mm T212 VULCAN II (Prototype)

GENERAL ELECTRIC



30mm T212 Vulcan II

History

Project Vulcan II was a program to design and build a 30mm multibarrel, power-operated automatic machine gun capable of very high rates of fire. Initial weapons were to fire at a rate of 4,000 spm (shots per minute), with an ultimate program objective of rates up to 6,000 spm (average for a two second burst).

General Electric's portion of the program was to design, build and test two T212 weapons, and to design an ammunition link with reliability comparable to that of the weapon. It did not encompass similar efforts on feed systems, controls, ammunition chuting, or external mountings.

Effort on the program started August 1, 1954. The first prototype weapon was completed in December 1956, and the second in January 1958. The contract ended May 15, 1958. The program extended much longer than was originally intended.

Authorization was received August 1, 1954 to start work on a 30mm gun design patterned after the M61 20mm weapon; the first weapon of this series was just being completed about that time. The 30mm Study Phase, completed in December 1954, showed that such a 30mm gun was feasible. Work went smoothly except for one problem: early single-shot firing tests by General Electric determined that the barrel-ammunition combination was not satisfactory. Changes in the barrel, requiring some redesign of the gun, eliminated this problem.

Characteristics

Bore Size	30mm
Muzzle Velocity	2846 fps
Rate of Fire	6050 rpm
Basic System of Operation	Power Driven
Locking System	Rotating Bolt
Power Source Feed System	Power Driven
Feed System	Sprocket Type
Type of Feed (Location)	Link
Method of Chambering	Ram
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	U.S. Army
Manufacturer	General Electric
Developer	General Electric
Gun Length	63.58 in.
Gun Weight	341 lbs.
Number of Barrels	6
Type of Firing Mechanism	Electric
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Mechanical
Miscellaneous	Only 2 built (1 electric and 1 hydraulic) Status - Prototype

General Description

As design and fabrication of the 30mm gun progressed, the 20mm program ran into difficulties in regard to case separation—where ammunition cases necked down, or stretched out to the point of separating during firing. Case stretch can only occur if the back of the cartridge case is not held firmly at the time of firing; that is, if the bolt or other gun parts can move backward. Preliminary investigations indicated that firing forces seen by the 30mm bolt (which used a dropping lock block, patterned after the 20mm bolt) were less than those seen by the 20mm bolt, and design and fabrication continued.

Performance Characteristics T212 30mm Automatic Gun

	Electric Drive	Hydraulic Drive
Maximum firing rate for a 10-round section belt (rounds per minute):	6050	5500
Acceleration time to above rate (seconds):	.782	.500
Shorter acceleration times have been recorded for lower firing rates.		
Dispersion: 80 per cent of rounds fired fall within a 9-mil dia. circle		
Recoil Travel:	0.75 in. maximum	
Recoil Force		
Average Steady-State Force	6,600 lb.(at 6600 rpm)	
Peak Recoil Force	12,500 lb.	

However, further investigations conducted on the single-shot test device indicated the 30mm lock was not entirely reliable in this respect.

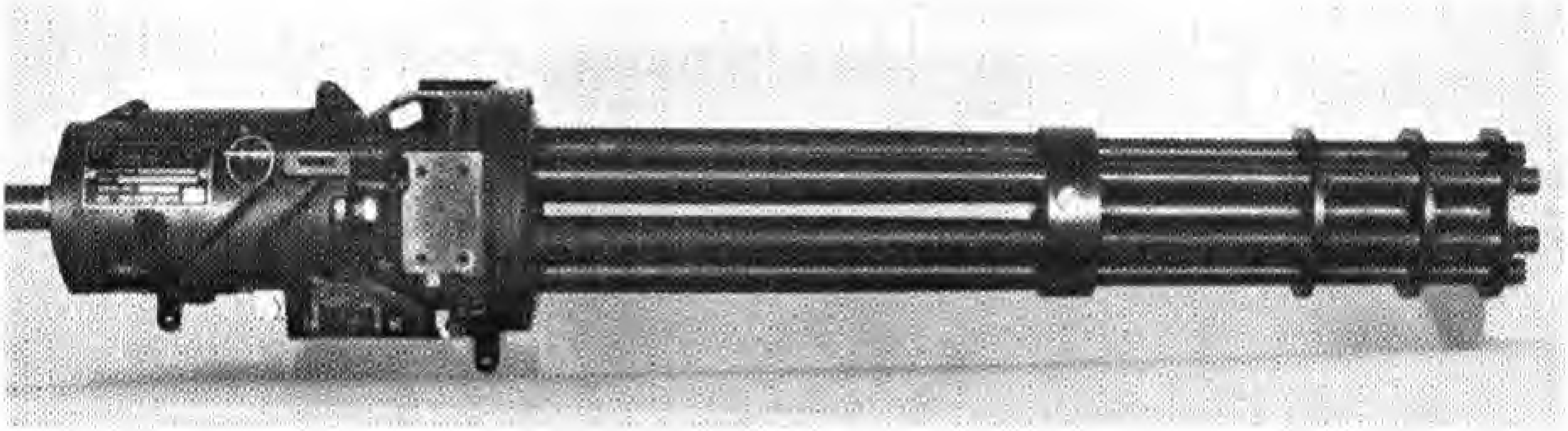
On September 21, 1955 General Electric was instructed to stop design and fabrication. A lock study was made to determine what locking method would be most satisfactory for the gun. The report on that study recommended that an interrupted lug lock patterned after the Model C Vulcan lock be used.

In September 1957 additional but limited funds were received. A General Electric program was conducted during the intervening months to start evaluating the first weapon. In December 1957 the No. 2 T212 weapon was completed. It underwent acceptance tests and was shipped to the Air Proving Ground Center, Eglin Air Force Base, on February 14, 1958 for performance evaluation. In April 1958 the first spare parts were made available to the Air Force for extended testing.

Chapter 4

7.62mm GAU-2B/A MINIGUN

GENERAL ELECTRIC



GAU-2B/A 7.62mm Aircraft Machine Gun

Introduction

The Minigun 7.62mm GAU-2B/A is the first descendant of the Vulcan M61A1 20mm gun to go into production manufacture at General Electric to satisfy the many needs of the U.S. Military and allies.

The Minigun is very much like the Vulcan. Their mode of operation is like that of the Gatling gun invented by Richard J. Gatling in 1862. They are multi-barrel guns. The barrels are in a rigid circle forming a cluster that rotate as it fires, one shot, one barrel at a time.

The Gatling was famous in its time because it could fire fast. A man could hand crank it over an extended period at about 100 revolutions per minute that would rotate its ten barrels, and so fire up to 1000 shots per minute.

The Vulcan and the Minigun modernized the old Gatling with up-to-date design and materials to fire high energy ammunition at rates up to 7200 shots per minute using electric or hydraulic motors.

The Gatlings fired from horse-drawn carriages. The jet-age Vulcans and Miniguns ride the U.S. front line fighter aircraft, helicopters, ships and ground tracked vehicles. Together with the new and innovative Linkless Ammunition Feed Systems that carry over 1000 rounds, the new Vulcans and Miniguns produce an awesome volume of reliable-sustained fire power that man could ever dream of from guns.

Other than being smaller and lighter, the Minigun differs from the Vulcan in the design of its gun bolts, which uses a stiff rotating bolt head that locks the breech while searing off its firing pin to percussion fire its 7.62mm ammunition.

History

Conceptual and analytical design studies started at General Electric in 1960 as Independent Research and Development projects. Component models were built and tested so that by early 1962 the Minigun design was established. A United States Air Force contract was awarded to General Electric later in 1962 and it called for prototype guns and gun pods.

The first Minigun burst was fired in December 1962; this was followed by the first firing of the gun pod (SUU-11/A) at Eglin Air Force Base in Florida in November 1963.

Both the Springfield Armory and Eglin Air Force Base conducted extensive live firing tests throughout

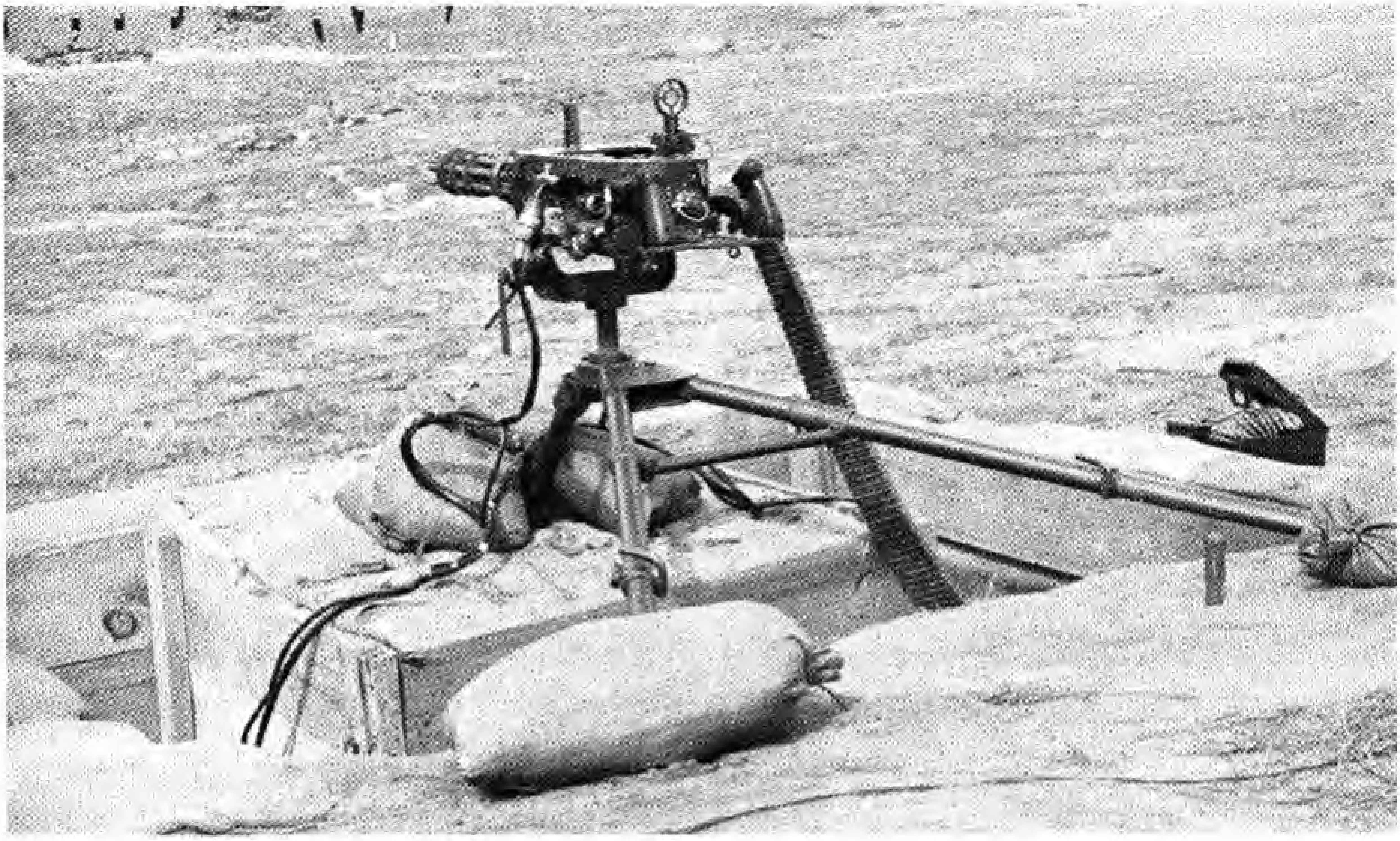
1964 accompanied by troubleshooting meetings and redesigns with General Electric.

"Side-Fire" which was the application of M37 machine guns firing out the port windows of a C-47 at ground targets was also in test at Eglin Air Force Base. They had difficulties obtaining a desired magnitude of sustained fire power from the M37 weapons. It became apparent to Mr. William Auman, the Air Force Project Officer at Eglin on Miniguns, that the Miniguns could perform like the already proven Vulcans and that the Miniguns could relieve the C-47 "Side-Fire" tests, and provide the needed reliable-sustained fire power. The switch in guns was made. The following tests were successful. The "Side-Fire" Gunship AC-47 left for Southeast Asia for trials and was in combat with Miniguns by December 1964.

The Miniguns were mounted in their prototype gun pods (SUU-11/A) inside the AC-47 at this time. However, earlier contracts had the improved design SUU-11/A pods in production, so that by September 1965 new pods were delivered to the AC-47 in Southeast Asia. The operation was soon nick-named "Puff-the-Magic Dragon" because of the extreme hail of fire that came from the AC-47 during night missions.

The "Side-Fire" missions were so successful, that by this operation, other applications, and state-side tests, the first one million rounds were recorded fired on Miniguns by late 1967.

Minigun Mounted in Helicopter



Minigun on the Firing Range

Minigun Pintle UH-1F

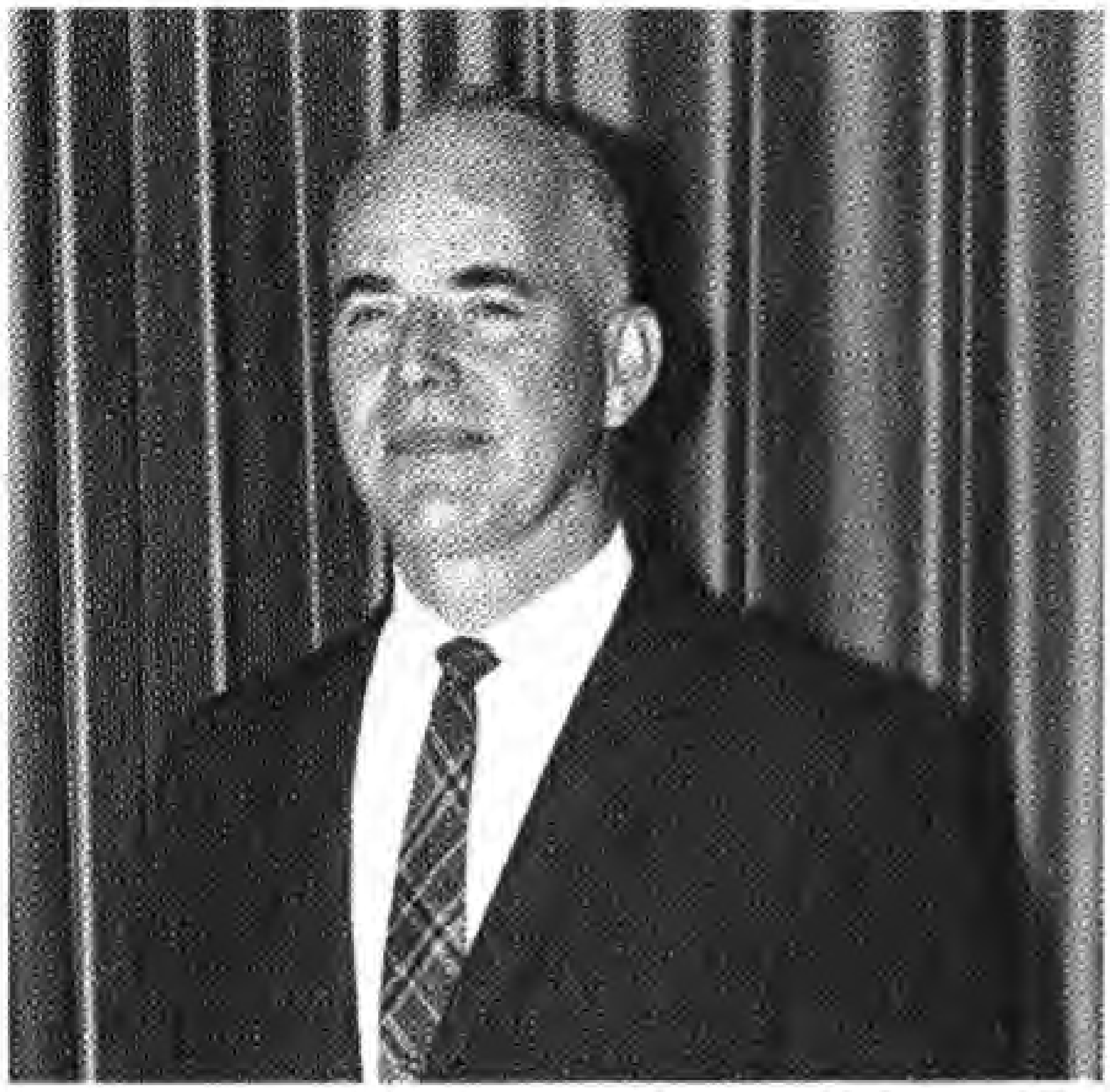
Production of Miniguns and various new application system components continues at General Electric. These included pintle mounts and turrets for helicopter, new modular systems for the gun ships and a nose system for the AT-37D fixed wing aircraft.

By January 1971, there were 10,000 Miniguns and 1500 Minipods produced by General Electric. By January 1972, there was recorded over 300 million 7.62mm rounds fired on Miniguns.

Minigun Operation

Firing Cycle. The firing cycle of the GAU-2B/A begins when mechanical power is applied to the front gear of the rotor assembly via the electric motor.

The rotor assembly and barrels rotate counterclockwise, viewed from the rear with firing taking place from 1:00 to 11:00. As the rotor assembly turns, the roller on the outer surface of each bolt assembly follows the somewhat elliptical cam path formed on the inner surface of the stationary gun housing. Each bolt assembly, in turn, picks up a cartridge from the guide finders on the feed side of the guide bar as that bolt passes the feed section of the cam.



John P. Hoyt, General Electric Armament Manager

Raymond A. Patenaude, Engineer in Charge of Development

The continuing camming action upon the bolt assembly roller moves the bolt assembly and cartridge forward to ram and chamber the cartridge in the barrel about to fire. At this time the previous barrel has fired and is about to unlock and extract.

After the cartridge has been chambered, the bolt head is rotated by the interaction of the bolt head helical camming surface and the bolt subassembly as the cam continues to push on the roller. As the bolt head becomes fully locked in this position, the firing pin has been rotated off the cocking shoulder in the rotor to release the firing pin to fire the cartridge. The bolt assembly roller has then reached the forward dwell portion of the elliptical cam and is held there during firing where pressure builds; the projectile leaves the barrel and the pressure decreases.

At the end of the cam's forward dwell the bolt assembly roller enters the reverse segment of the cam path. The bolt head unlocks by reverse cam action with the body bolt. Further travel of the bolt assembly roller along the cam's reverse segment moves the bolt assembly to the rear and extracts the spent cartridge case from the barrel chamber.

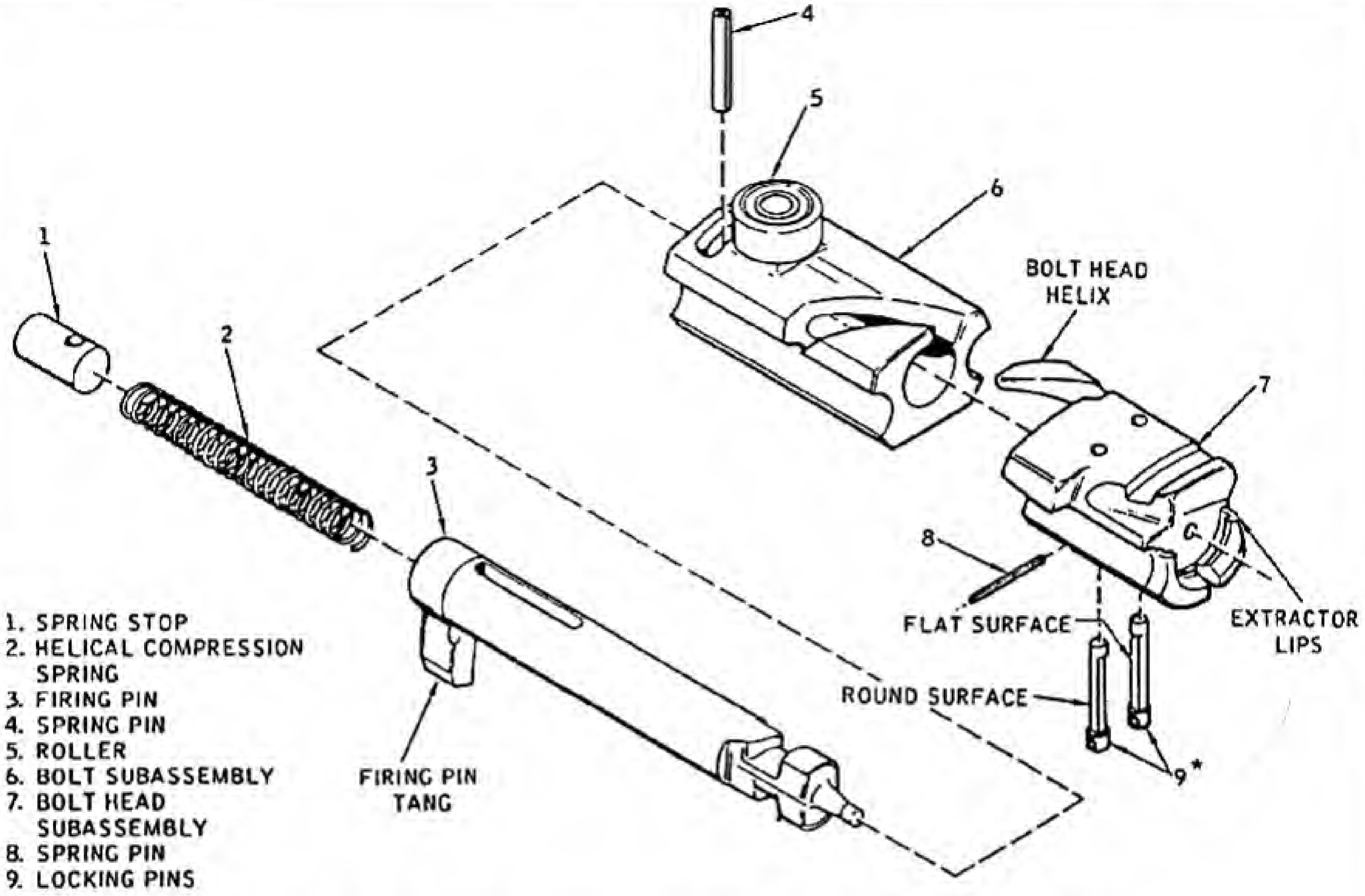
An extractor lip on the face of the bolt head holds the spent case until it is cammed out by the ejection side of the guide bar and ejected. The bolt assembly continues to follow the rear dwell of the cam path into a position to receive another new cartridge from the feeder. At this point the bolt assembly has completely cycled through the gun and the elliptical cam path. All six bolt assemblies continually repeat this cycle one at a time while power is applied to the front gear of the rotor assembly.

While one bolt assembly has passed the feed position and ramming, the bolt ahead is about to lock and fire. The next bolt ahead has fired and is about to unlock. The third bolt ahead is extracting a fired case. The fourth bolt ahead has extracted and is getting ready to eject. The fifth bolt ahead has ejected and is in rear dwell.

The six bolts, as are the barrels, are spaced 60° apart from each other, and each is performing one of the gun cycle functions of feed, ram, lock, fire, unlock, extract, and eject. Of course, as another 60° rotation of the rotor occurs, each bolt advances to the next gun cycle function directly ahead of it and so on as the gun rotates and fires.

Clearing. Gun clearing is provided at the end of each burst by a by-pass feature in the feeders that is solenoid controlled. The by-passed ammo exits the feeder and is sent overboard. This happens during gun coast down at the end of a burst leaving the gun free of ammunition.

A clutch can be used instead of by-pass clearing to stop the flow of ammo into the gun during coast down which also leaves the gun free of ammunition without ejecting live rounds overboard.



1. SPRING STOP
2. HELICAL COMPRESSION SPRING
3. FIRING PIN
4. SPRING PIN
5. ROLLER
6. BOLT SUBASSEMBLY
7. BOLT HEAD SUBASSEMBLY
8. SPRING PIN
9. LOCKING PINS

*NOTE: LOCKING PINS (2) ROUND SURFACE MUST BE FACING OUTSIDE SURFACE OF BOLT HEAD, AND CENTER FLAT SURFACE TOWARD FIRING PIN (7).

Bolt Assembly - Exploded View

Gun Bolt Operation and Description

The Minigun gun bolt is simple and rugged. It has three major parts, the bolt body with roller, the bolt head and the firing pin with spring.

The gun bolt operates in typical Vulcan/Gatling fashion by being driven around the gun by the interaction of the rotor revolving inside the fixed gun housing. The gun bolts, there are six, one for each barrel, rotate with the rotor and can slide fore and aft on longitudinal rotor trackways. The fixed main cam on the inside of the gun housing, drives the gun bolts forward and aft in that the gun bolt's roller rides in this cam as the gun bolts rotate with the rotor.

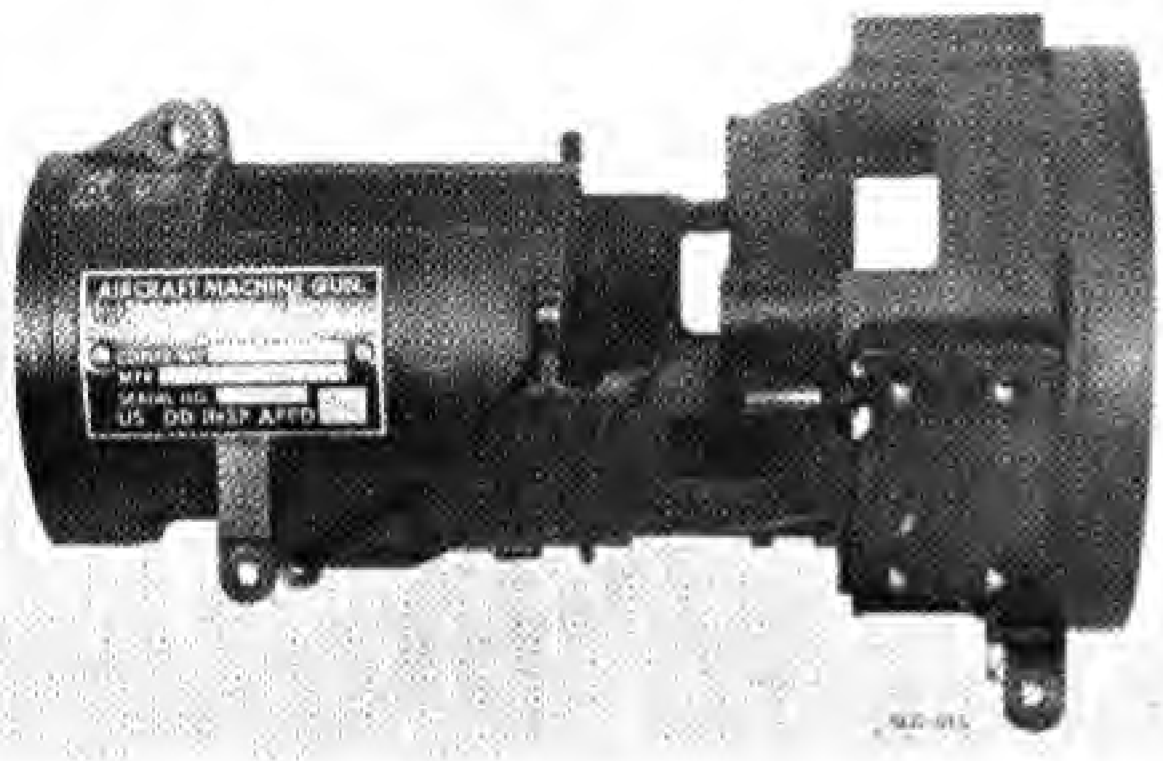
The gun functions of feed, ram, lock, fire, unlock, extract and eject are performed at specific locations on the fixed housing and main drive cam. The gun bolts experience these functions as they pass these locations.

The gun bolts have a fixed extractor lip at the front of the bolt head. This lip is to hold the round of ammo at all times while the ammo is in the gun. It also provides the pull on the spent cases after the round has fired and is being extracted from the chamber.

On the top of the bolt head is a machined pathway transverse to the axis of the head. It is there as a guide-way that interfaces with a guide on the guide bar to line up the incoming round of ammo with the head's extractor lip during feeding, to ensure the round entering the lip during all tolerance and application conditions.

The bolt head is assembled to the bolt body subassembly by inserting the firing pin and spring inside the body and inserting the restraining roll-pin into the firing pin through the slot in the rear of the body. This allows the firing pin to rotate about its axis about +10° as the slot and pin permit. The firing pin can also move to the rear against the force of its spring, but it can only move forward until its tong touches the back end of the body, which it does since the spring has a preload.

The bolt head is simply slipped over the forward end of the firing pin; the end of the male helix on the head mating with the beginning of the female helix on the body. The forward end of the firing pin enters the square inside the head created by the two locking pins. A gap remains between the bolt body and the head.



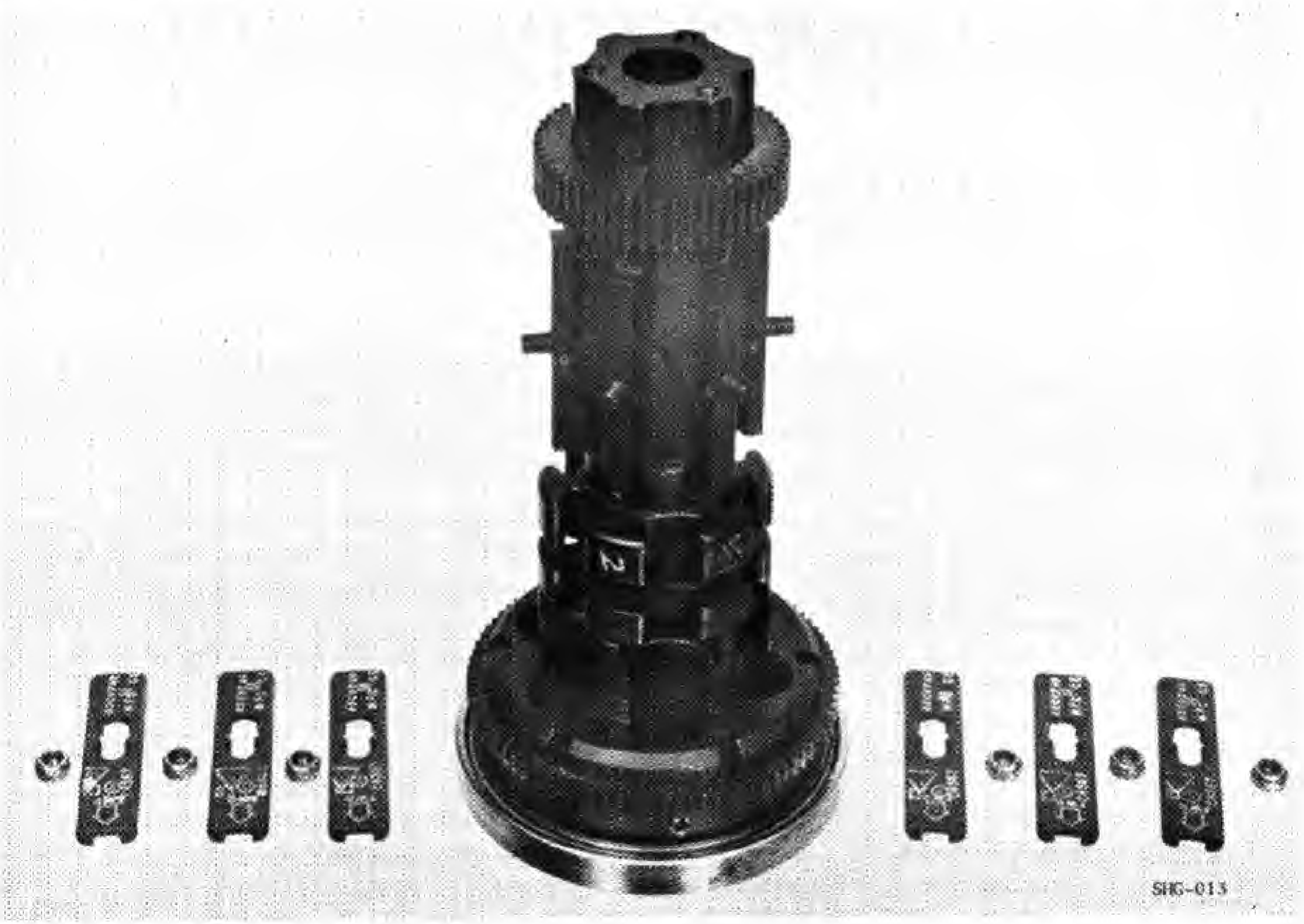
Gun Housing Assembly

The bolt head is free to be disengaged from the body and the firing pin when the complete assembly is out of the gun, but, when in the gun, the head is restrained from turning by the rotor tracks, and cannot come apart.

The roller on the bolt body is a permanent assembly. The roller rides on a machined-in shaft. The shaft is then spun over the roller, capturing it.

When in the rotor trackways, the firing pin will not protrude from the firing pin hole in the bolt head face. The gun bolt rides in this manner while in the back side of the gun during extraction, ejecting, feeding and ramming.

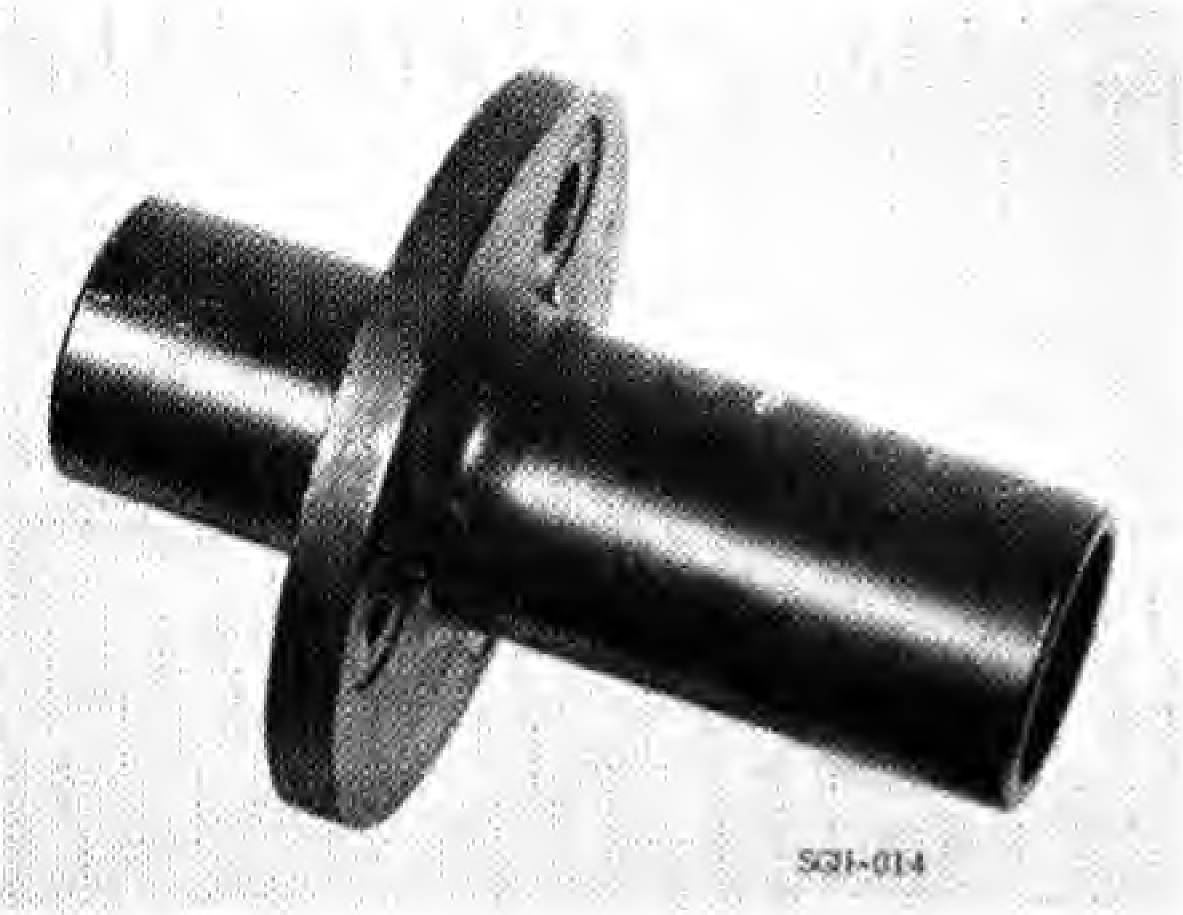
To lock the bolt and fire the round, the gun bolt must complete its ram stroke chambering the round.



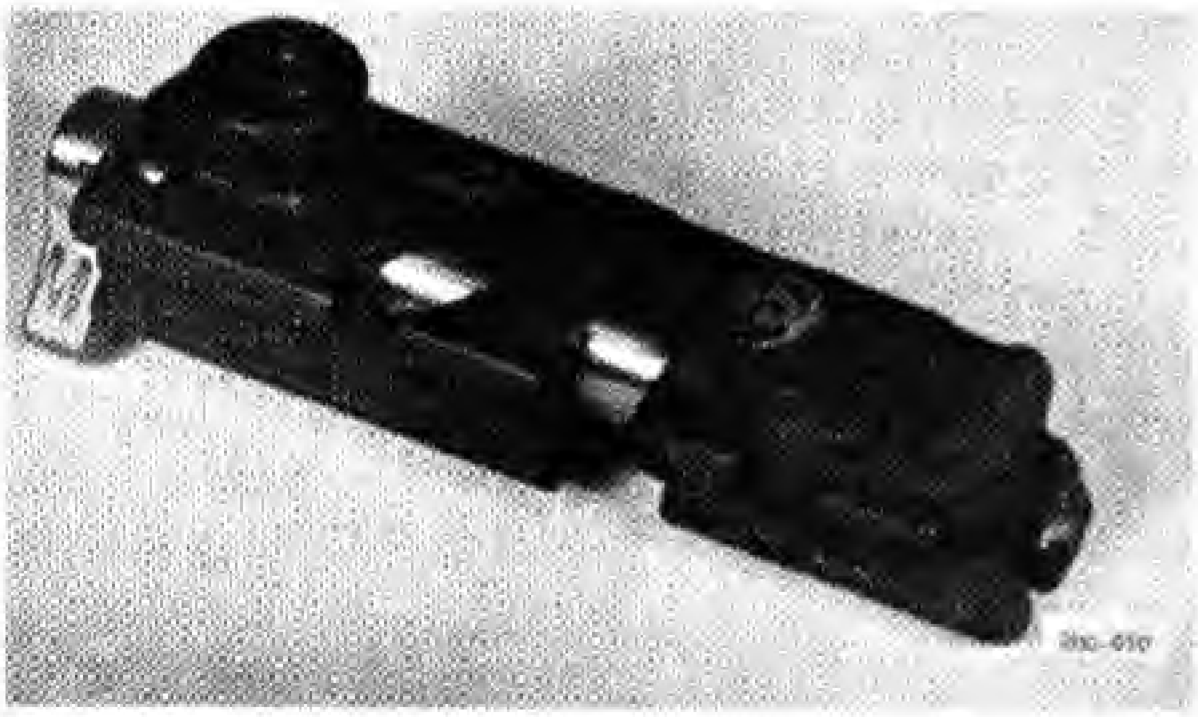
Rotor Assembly and Removable Tracks

At this time, the front end of the head's lip contacts the face of the barrel. The bolt head cannot travel any further forward, but the bolt body can since its roller has not yet reached the end of the main cam. So, the body continues to push forward closing the gap between the body and the head.

The head now has run off the rotor tracks and is supported by the firing pin. The firing pin tang has made contact with the cocking shoulder in the rotor so that the pin cannot move any further forward and the spring starts to cock.



Aft Gun Support

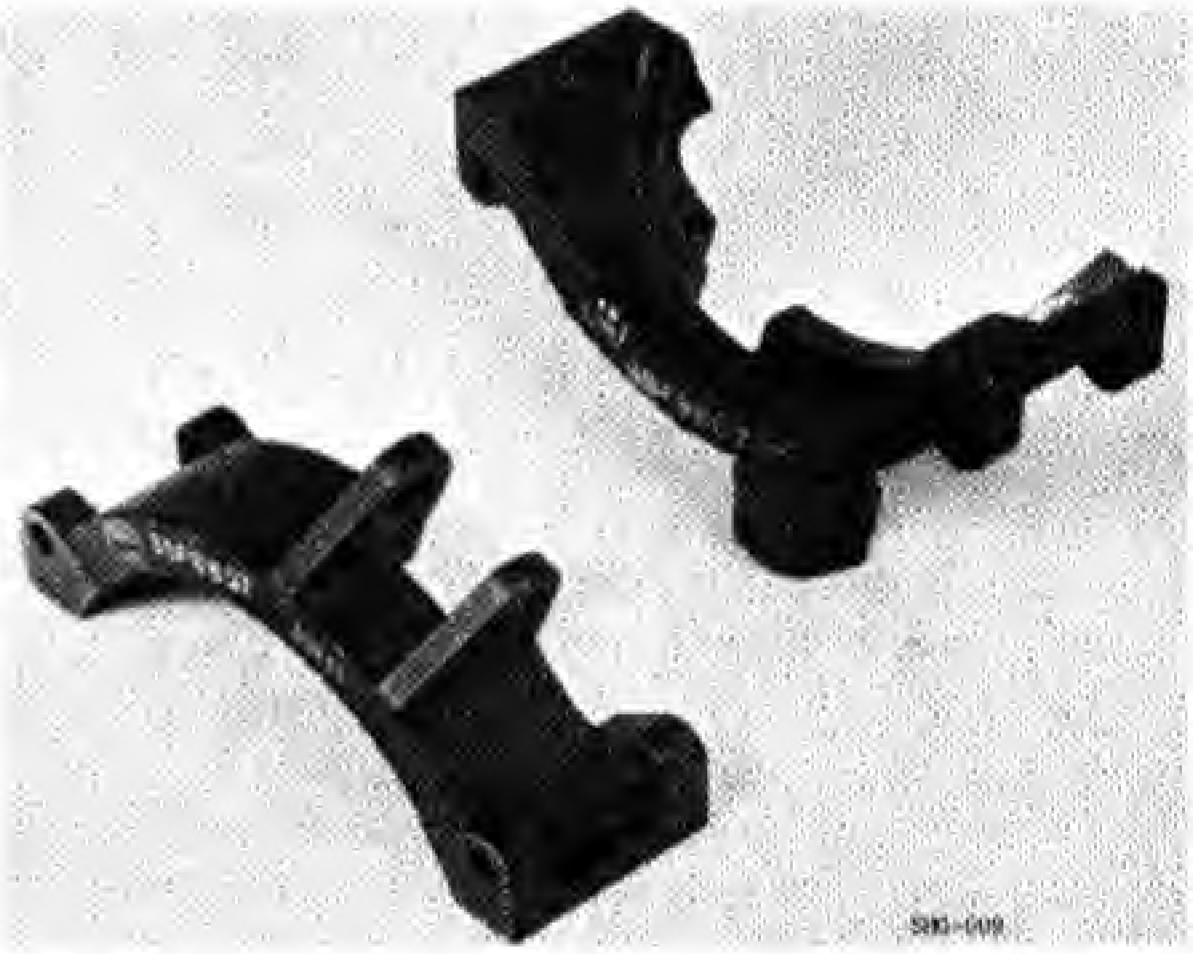


Bolt Assembly

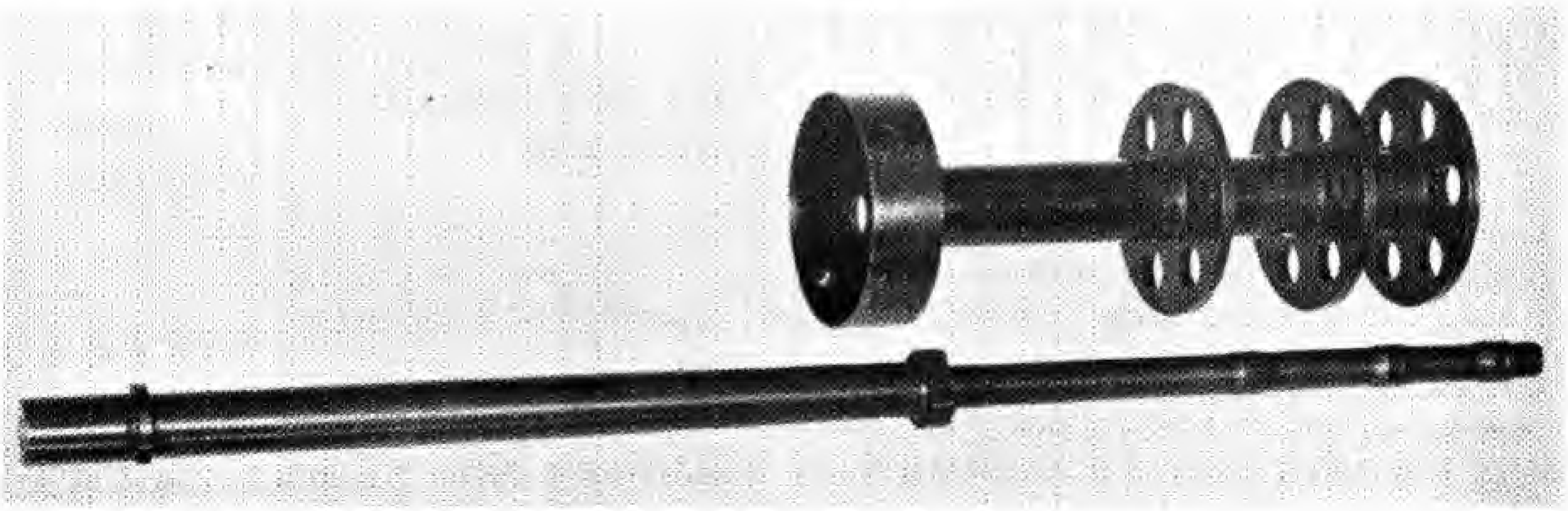
Description of Major Components

Gatlings, Vulcans and Miniguns seem to be complicated; but, in reality they are very simple. The number of six barrels and six gun bolts adds to the total number of parts; however, after barrels and bolts all other parts are singular, like one housing, one rotor, one feeder, one guide bar, etc. Of course, there is always an exception—there are two recoil adapters.

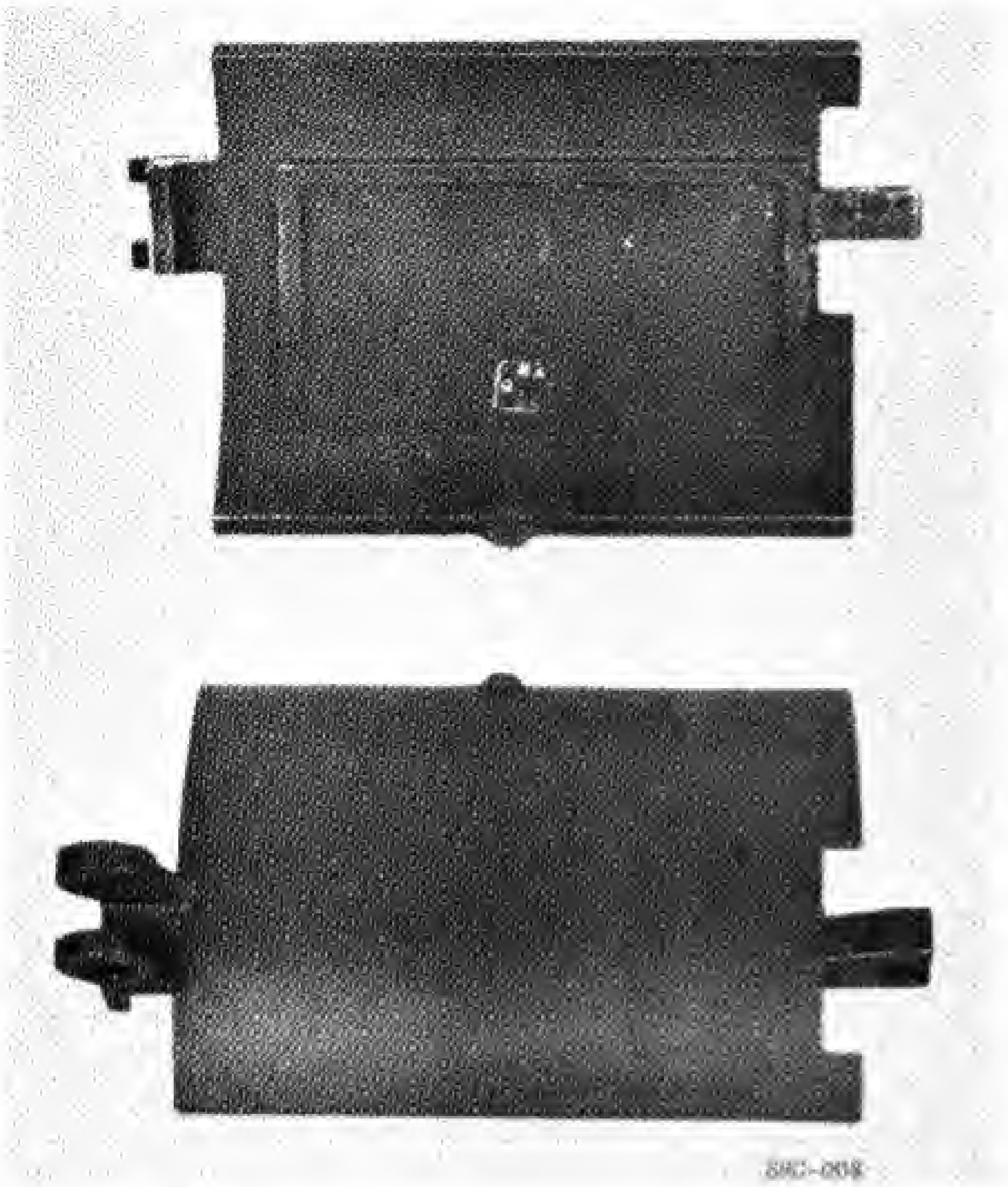
The rotor fits inside the housing and is positioned there by angular bearings at each end of the rotor.



Safing Sector



Barrel and Barrel Clamp Assembly



Housing Cover

The aft gun support is also an end plate that bolts to the rear end of the rotor setting up a slight preload on the bearings and locking the rotor radially and longitudinally inside the housing.

The six barrels can be placed in their mating holes in front of the rotor. Each barrel is locked longitudinally to the rotor by turning it 180° so that the barrel lock shoulder enters its lock groove on the rotor.

There is one barrel clamp. It is placed over the barrels with each barrel entering its in-line series of holes on the four stiffening plates on the barrel clamp. The rear most plate is actually a cup that fits over the shoulders at mid barrel. There is a tangential cut on all these barrel shoulders that are all outboard to the barrel cluster when the barrels are locked so that these cuts allow the cup to slip over them. With this done, the barrel clamp is in place, preventing the barrels from turning and hence maintaining the barrel locks in the rotor. A single bolt is pushed radially through the cup behind the shoulders on two barrels 180° apart. The bolt is threaded into a captured lock nut on the other end of the cup securing the barrel clamp to the barrel cluster. A ¾° cone is machined into the barrel clamp holes, hence the cluster maintains this cone used to minimize target bias shift if fired at different firing rates.

The six gun bolts are placed inside the gun housing and onto the rotor's trackways. The housing cover that allows gun bolt access is removed while inserting the gun bolts. Also, the six rear tracks are removed from the rotor.

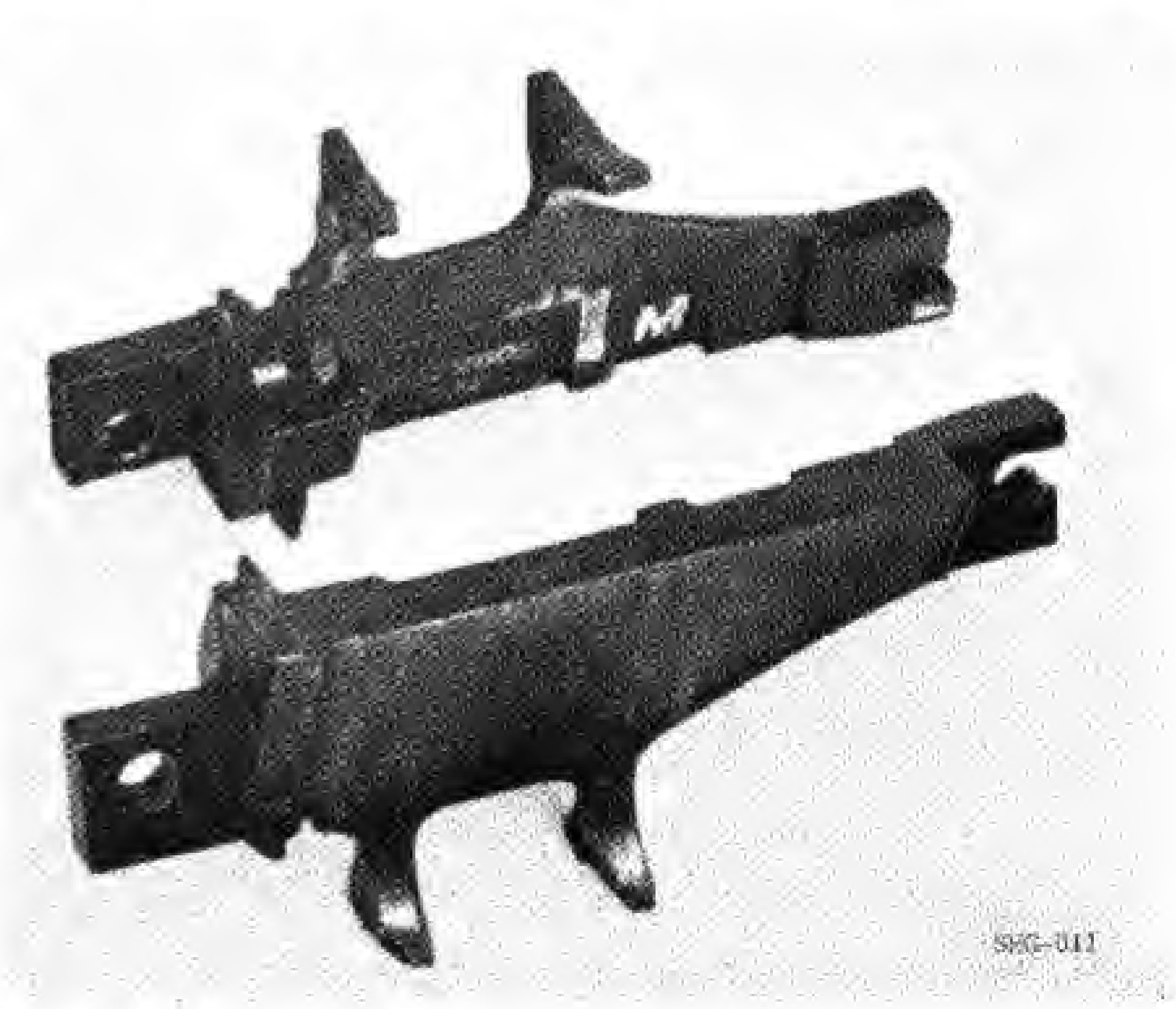
The procedure for installing the gun bolts starts with securing one removable track on the rotor and tightening its lock nut. With the operator standing behind the gun, place this first track on his left side. Put in a gun bolt to the right of this track, and slide it forward (the safing sector is removed).

Rotate the gun counterclockwise and install the second track, and then the second gun bolt. Rotate and repeat until six tracks and six gun bolts are installed.

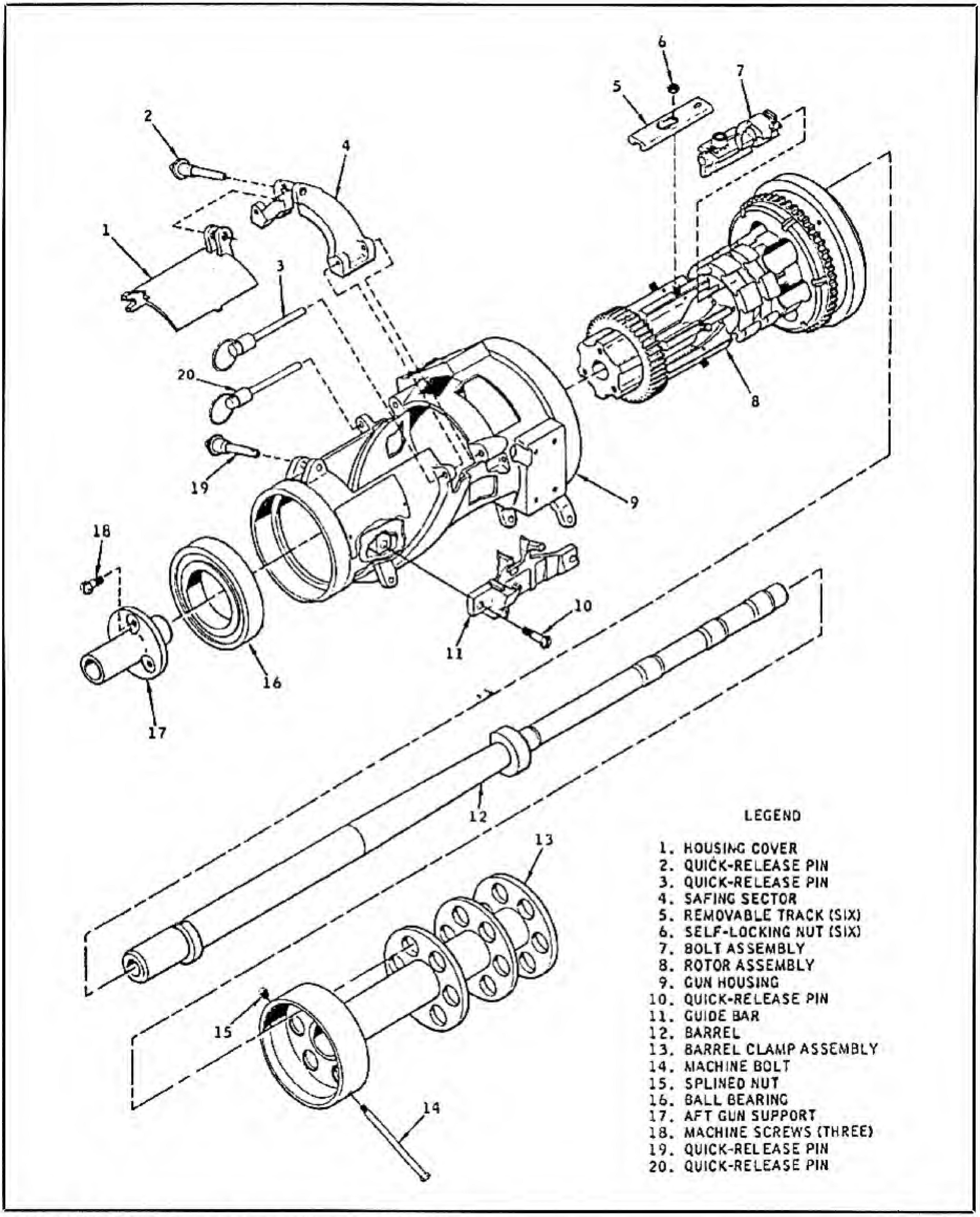
Install the safing sector with two quick disconnect pins. One gun bolt is at top-dead-center with its roller in the slot in the sector this bolt's firing pin spring is not compressed.

Install the housing cover by first putting in its forward quick disconnect pin with the cover up at an angle. By lowering the cover, the top-dead-center gun bolt is forced into the safing sector compressing its firing pin spring. Install the lock pin at the rear of the housing cover.

The bolt body is driven further forward by the cam and roller. This causes the body's female helix slot to push, torque, on the male helix and rotate the bolt head. As the bolt head rotates, it rotates the firing pin by the head's locking pins pushing, providing a torque, on the firing pin forcing the tang



Guide Bar



LEGEND

1. HOUSING COVER
2. QUICK-RELEASE PIN
3. QUICK-RELEASE PIN
4. SAFING SECTOR
5. REMOVABLE TRACK (SIX)
6. SELF-LOCKING NUT (SIX)
7. BOLT ASSEMBLY
8. ROTOR ASSEMBLY
9. GUN HOUSING
10. QUICK-RELEASE PIN
11. GUIDE BAR
12. BARREL
13. BARREL CLAMP ASSEMBLY
14. MACHINE BOLT
15. SPLINED NUT
16. BALL BEARING
17. AFT GUN SUPPORT
18. MACHINE SCREWS (THREE)
19. QUICK-RELEASE PIN
20. QUICK-RELEASE PIN

GAU-2B/A 7.62mm Aircraft Machine Gun - Exploded View toward the end of the cocking sear in the rotor.

As the body approaches the end of its forward travel, it has rotated the head to its locked position, and compressed the firing pin spring. The last bit of rotary action of the head sears off the firing pin and the pin enters the rounds prime and fires the round.

The ends of the rotor's tracks take the breech loads since the rotated head has projections, lock bearing areas, that line up with the ends of the tracks when the head is fully rotated and the round fired.

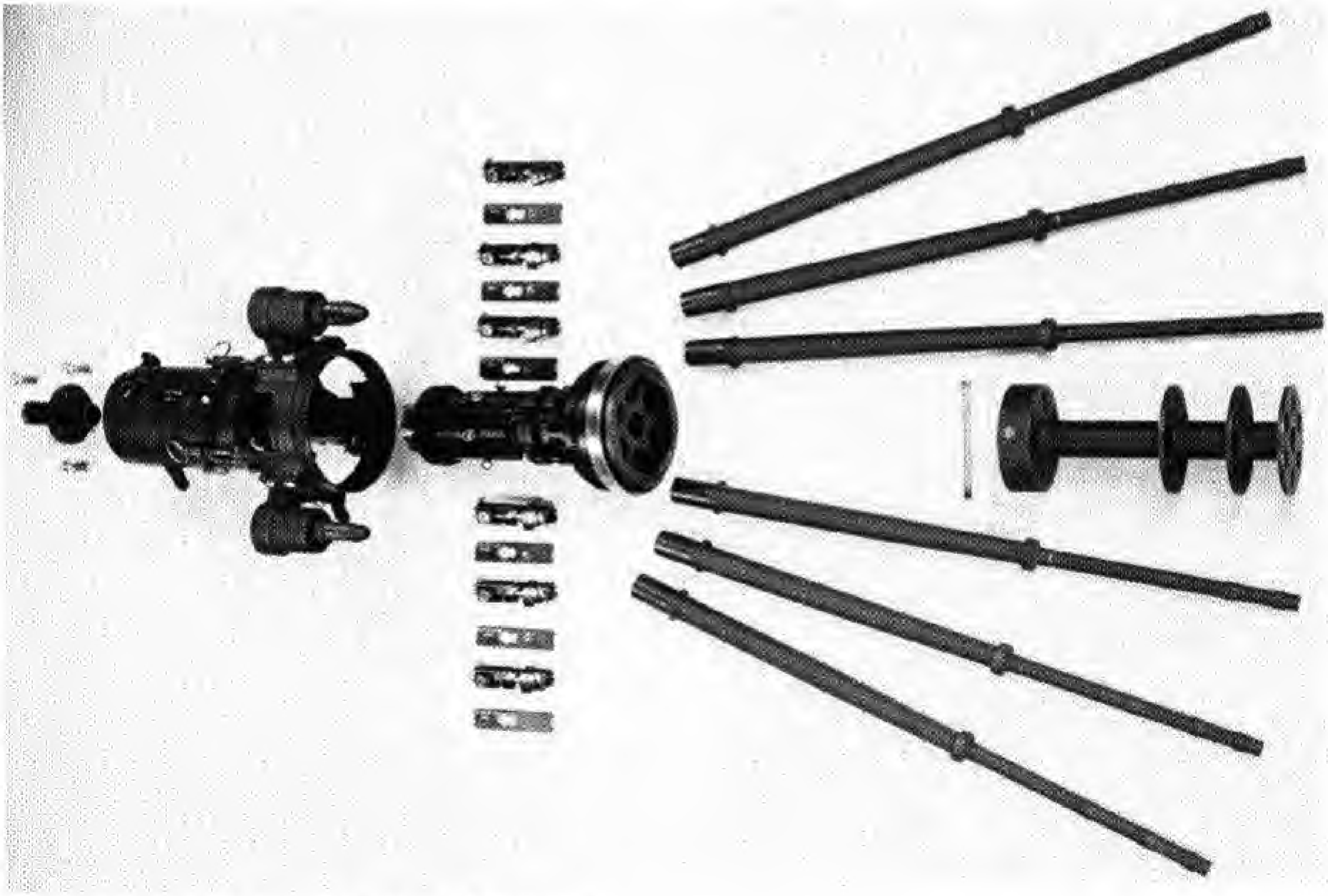
The gun bolt stays locked throughout the 60° firing sector, at the end of which unlock starts. The roller enters the main cam and starts rearward so that the body's female helix slot forces the head to rotate and unlock, but the firing pin cannot rotate, and it is all the way forward and its tip still protrudes.

The body proceeds to the rear as the head continues to turn and unlock. The locking pins in the head rotate around the end of the firing pin where there is a circular cut, and at the end of rotation they are located behind the cut or groove on the end of the unrotated firing pin. The firing pin tang contacts the rear of the body and is carried to the rear with the body. The pin then makes a rearward contact with the heads locking pins and firing pin pulls the head to the rear. The head during the last bit of rotation is lined up with the end of the rotor's tracks. The line of action now is that the roller is pulling the body to the rear. The body pulls the firing pin. The firing pin pulls the head and the head pulls the empty case out of the chamber for case extraction.

On the way to the rear, during extraction, a long shallow cam in the rotor's trackway in which the tang travels, rotates the firing pin from its fired position.

This continues to the end of the extraction stroke where the case is ejected via the guide bar, a new round feeds into the bolt face and lip and the cycle starts over.

At rear dwell the tang has rotated to its other extreme, locking with the head's locking pins during rear dwell, and hence feeding and the beginning of



GAU-2B/A 7.62mm Aircraft Machine Gun Components

Characteristics

General:	
Calibre	7.62mm
Gun, Overall Length	31.5 in.
Gun, Weight	35 lbs.
Cooling	Air
Muzzle Velocity	2,850 fps
Rate of Fire (steady state)	6,000 spm
Operating Temperature Range	Minus 65° F. to Plus 165° F.
Barrel:	
Length	22.0 in.
Weight	1 lb., 1 oz.
Rotation of Barrel Cluster	Counterclockwise viewed from Breech End
Barrel Rifling:	
Grooves	4
Twist	Right Hand
Length	20 in.
One Turn In	10 in.
Ammunition:	
Cartridge, 7.62mm, AP, NATO	M61
Cartridge, 7.62mm, ball, NATO	M59
Cartridge, 7.62mm, ball, NATO	M80
Cartridge, 7.62mm, tracer, NATO	M62
Cartridge, 7.62mm, dummy, NATO	M172

ram. Halfway on the ram stroke, the tang is cammed to a straight down position as it waits to hit the cocking shoulder.

The gun bolt assemblies as well as the barrels, rotor etc., are precision machined. This, together with gun drawing tolerances that assure 100% interchangeability of gun parts, has eliminated all need for adjustments and/or shims. This permits the gun to be serviced during scheduled maintenance at the lowest level of replacement of part and that of qualified personnel.

The safing sector contains the forward part of the gun housing's main bolt driving cam. This includes part of the cam that locks the bolt (and sears off the firing pin), the front dwell (firing sector), and part of the cam that produces unlock of the bolt.

When the safing sector is removed the gun can be rotated by hand and the gun bolts cannot fire. The sector is removed during maintenance purposes.

With the sector installed, the gun will fire if it is rotated (with ammo, of course), even if rotated by hand.

The guide bar is assembled to the housing by slipping its forward end over a permanently installed pin, and placing a bolt through the hole on its aft end and tightening the bolt in the in-place lock nut.

The guide bar has two double guides that stick into the housing. On the eject side the spent cases or duds are cammed out of the rotor and housing and discarded overboard. On the feed side, new ammo is assisted into the gun housing, and hence into the gun bolt's extractor lip being ready for the ram stroke.

Two recoil adapters can be bolted on each side of the gun housing, thus forming gun mounts, the third singular mount being at the rear of the gun. The centerlines of the two recoil adapters are slightly below the level of the firing barrel. Inside each adapter is an energy absorbing material to help reduce peak recoil loads to grounds, and to produce a minimum load during steady state full rate firing.

A gun electric drive bolts to the gun housing with the drive's output gear meshing with the forward gear on the rotor to drive the gun at 6000 spm. Variations of this drive can fire the gun at other rates from 200 spm up to 7200 spm. The gun drive can be AC, DC or hydraulic.

Gun Feeders

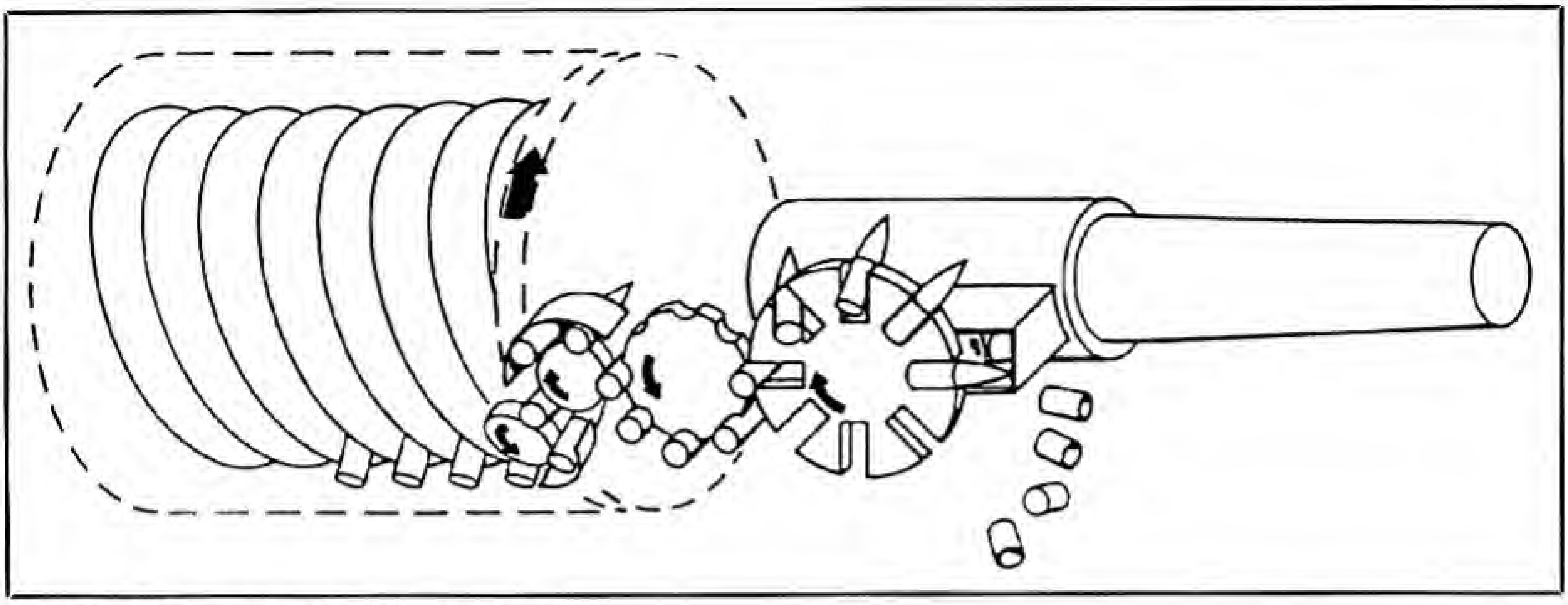
Delinking Feeder. The gun feeder is a multifunctional unit. It accepts belted-linked 7.62mm ammunition. The rounds are end stripped, cammed into a paddle wheel shaped sprocket, expanded to gun rotor pitch and fed into the gun. By-pass clearing is provided at the end of each burst. As an alternative, the gun feeder can be used with the rotor clutch to stop the flow of ammunition into the gun at the end of the bursts.

The delinking gun feeder is made up of only one shaft that is mounted inside a multi-diameter housing that admits linked ammunition tangentially into its rear section and delivers timed up-to-speed rounds to the gun from its forward section.

The feeder meshes with the rear rotor gear. On the rear of the feeder is a cammed push-rod mechanism that has six push rods that contact the base of the linked round just ahead. The push rods rotate on the feeder shaft and are driven forward by a roller on their aft end that rides in a fixed cam.

The linked rounds are wrapped around a sprocket on the feeder shaft so that as the shaft turns the belted ammunition is dragged into the sprocket. Once the linked round is seated in the sprocket, the push-rod starts to push the round ahead while holding the link on the sprocket.

The round is pushed fully forward of the link in a



SUU-11/A Minigun Pod Linkless Feed System

180° turn of the shaft. The push rod will be retracted through the link while the link is still in the sprocket. The link will leave the feeder just above the belted ammo that is entering. The disintegrated link is discarded.

The round is still on the feeder shaft being turned by the continuing sprocket. The base of the round contacts a cam on the housing and is cammed into the large diameter paddle wheel while traveling another 180° about the feeder shaft.

At this point the round will do one of two things. If it is going into the gun to be fired, it will stay in the paddle-wheel and will be expanded radially up to gun pitch and handed off to the gun bolt as it enters the gun. This will also take 180° so that the round has traveled one and one-half rotations around the feeder shaft from when it entered as a linked round until it leaves to enter the gun.

If the burst is over, and the round wants to be cleared and not enter the gun, it will be by-passed through the clearing gates that are opened by a solenoid and be discarded. This happens during gun coast down so that the gun is clear of all ammo when it stops.

The clearing gates are reset at the beginning of the next burst so that the rounds enter the gun for firing.

Clutch Clearing. A traveling circular knife-dog clutch can be interchangeability assembled to the rear of the rotor. When activated by a solenoid it will declutch the rear gear from the rotor and lock it to the fixed housing.

The delinking feeder is geared to the aft rotor gear, so as the clutch stops this aft gear during gun coast down after a burst, the feeder also stops and no ammunition is fed into the gun. When the gun stops, it is clear of ammunition.

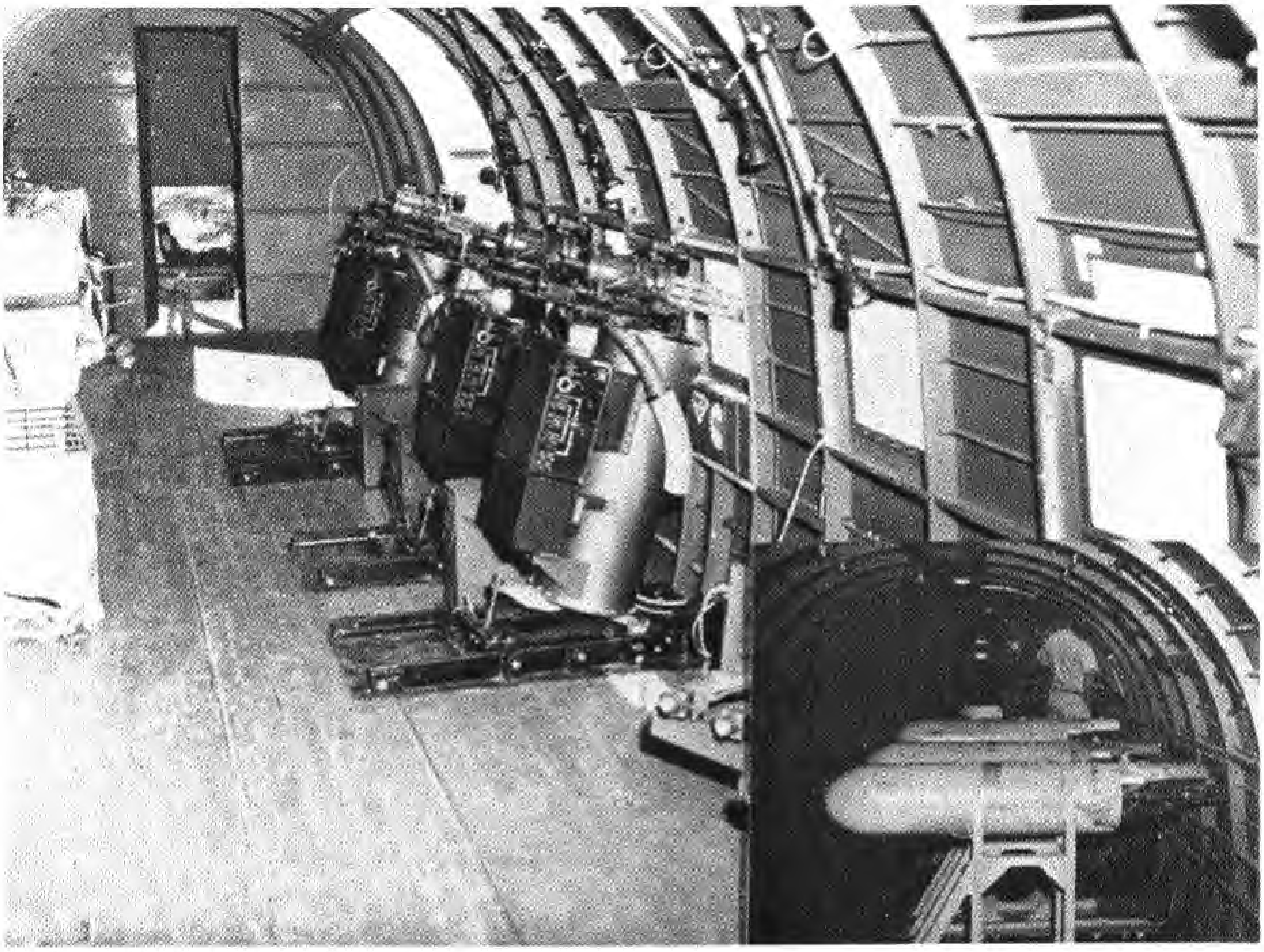
This clutch can be used on other Minigun systems such as the mini-pod to provide gun clearing without discarding unfired ammunition overboard as is done by by-pass clearing installed in all the Minigun feeders. The clutch re-engages automatically at the start of the next burst.

Minigun Linkless Feed Systems and Other Linked Systems

The Minigun Ammunition Handling Systems benefited from the design and test work done on the Vulcan 20mm ammunition systems, since in the early 1960's when the Minigun systems were formulating, the Vulcan M61A1 was already in successful operation on the U.S. Air Force F106D with its Linkless Feed System. Another factor aiding the Minigun was that the 7.62mm link was an end stripping link, being a little stronger, and handling less mass than the side stripping 20mm links.

However, the Minigun 7.62mm link was still marginal, because of link stretch and belt pitch change function when fired at 6000 spm and required some unique, creative type storage and feed systems when using the link even at 4000 spm.

The Minigun never used a double-ended Linkless Feed System in any of its installations which were so favorably utilized on most Vulcan 20mm applications. In fact, the Minigun used only one approach to the classic Vulcan Linkless Feed System when the Minigun pod (called the Mini-Pod) was designed in

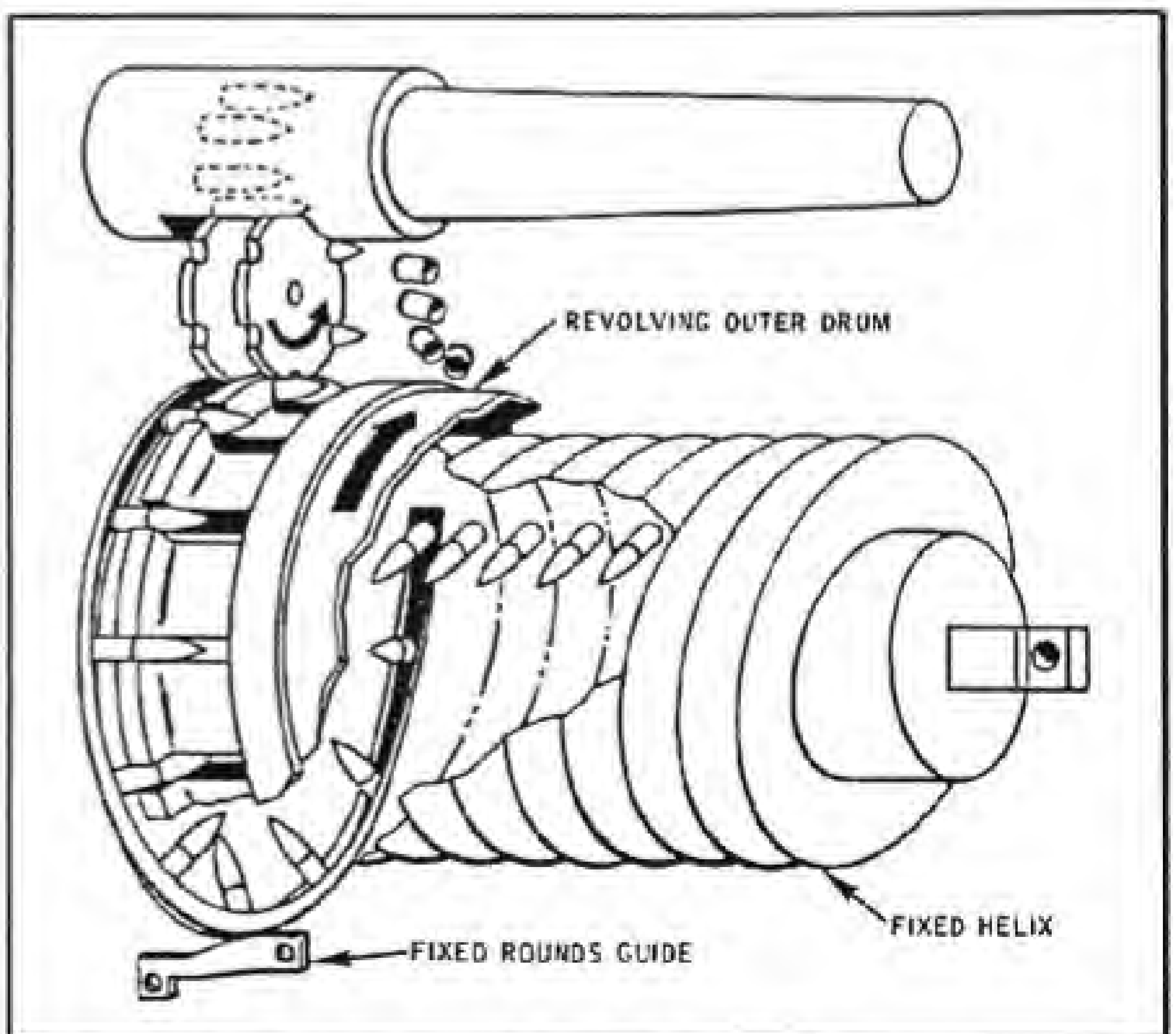


Minigun Mounted in a C-47 known as "Side-Fire". In the Right Corner is the Original Mounts.

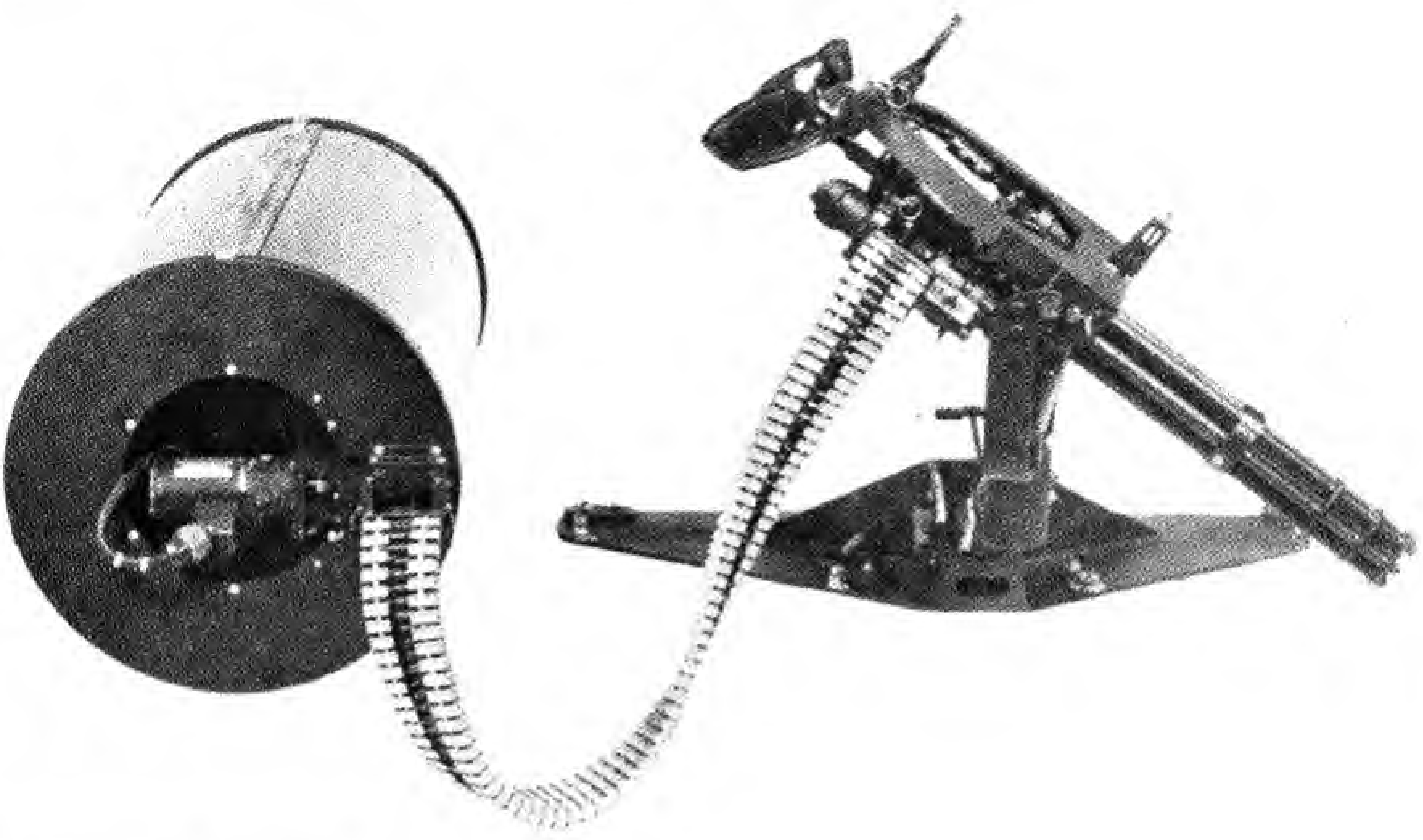
1963. This was a single-ended system with a new ammunition conveyor wheel between the exit of the drum and the entrance to the gun.

There were two other Minigun single-ended Linkless Feed Systems designed and used in speciality installation. The first was the Minigun Module for "Side-Fire" and the second was for the nose gun bay of the AT-37D.

The "Side-Fire" module was a one-way linkless vertical storage drum with a horizontal Minigun on top of it. The drum had a single-lead helix on the inside of the fixed outer drum in which the butts of the rounds rode. The rounds had their projectiles pointing radially toward the center of the drum. Inside the drum was a paddle-wheel inner drum that did turn. The paddles extended radially outward over the projectile end of the rounds, so that as the paddle wheel inner drum turned it forced all the



Minigun Internal Assembly Linkless Feed System



Universal Rotary Ammunition Handling System

ammo to advance up the single lead fixed helix. At the end of the helix on top of the drum was a fixed sprocket that captured all rounds as they came to the end of the helix one at a time.

The axis of this sprocket was also radial to the drum. The Minigun feeder was located directly over this sprocket so that the ammo was handed immediately to the feeder with no orientation change. This was the utmost in simplicity of design that paid off handsomely in the extended reliability so obtained and needed on "Side-Fire."

On the AT-37D a one-way Linkless Feed System was devised that sat parallel to the axis of and beneath the Minigun. This storage drum was the opposite of the "Side-Fire" module. The inner drum was a fixed single lead helix. The outer drum rotated and had radial fins on the inside that ran longitudinal the length of the drum. The ammunition was also radial with the projectiles pointing toward the center of the drum.

As the outer drum turned, all rounds advanced toward the end of the helix one round at a time. At the end of the helix all rounds entered a fixed rim guide that captured all rounds by their extractor groove. The rounds were moved along the rim guide by slots at the end of the turning outer drum. The rim guide twisted to change the orientation of the rounds from radial to the drum when they entered the guide to parallel to the axis of the drum; each round still being moved by the slots on the end of the turning outer drum.

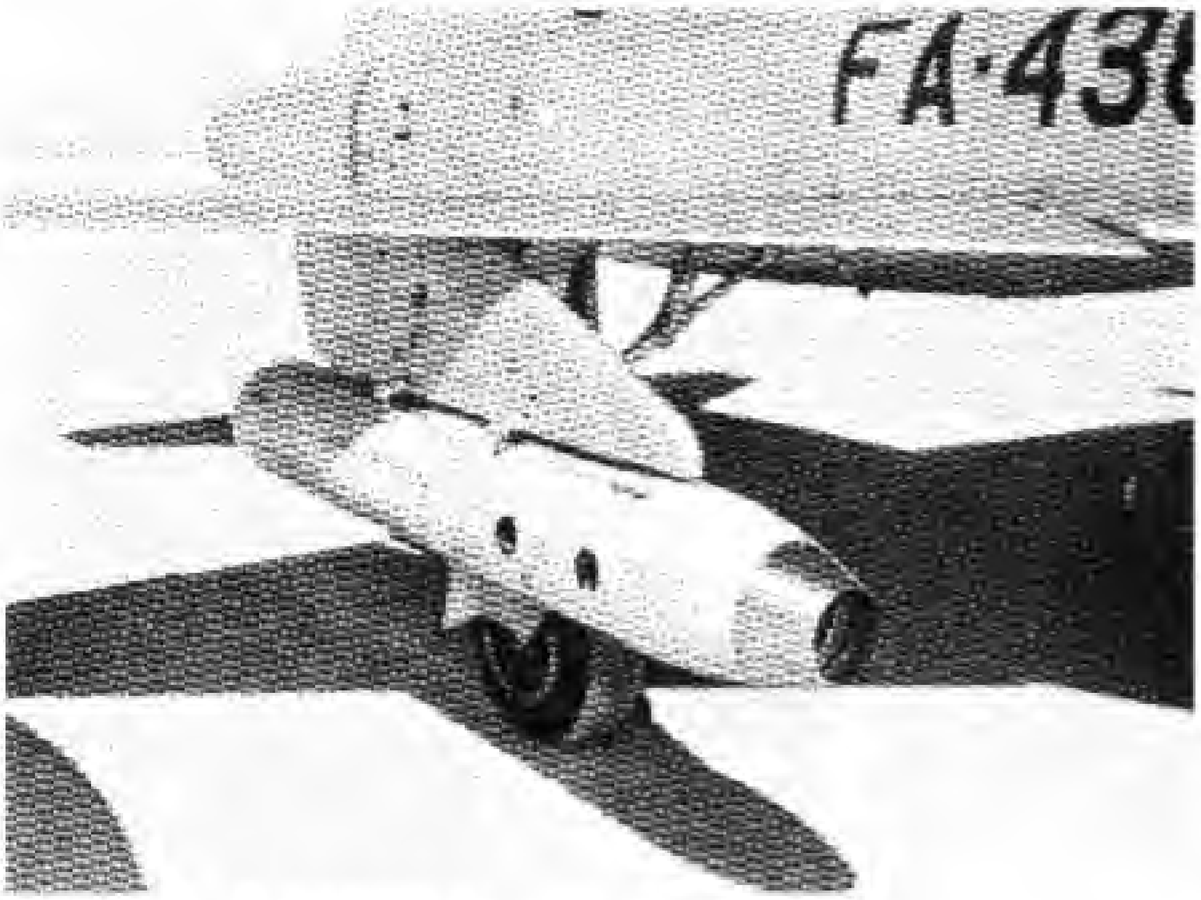
The rounds at the end of the rim guide were also parallel to the axis of the Minigun, and to the feeders sprocket shaft. The rounds were there picked off the rim guide by the sprocket, adjustments made to their pitch, handed off to the gun and fired.

The rest of Minigun Feed Systems used were linked systems that fired at 4000 spm. Two of these systems used rotary drums with the linked ammo stored in the drums.

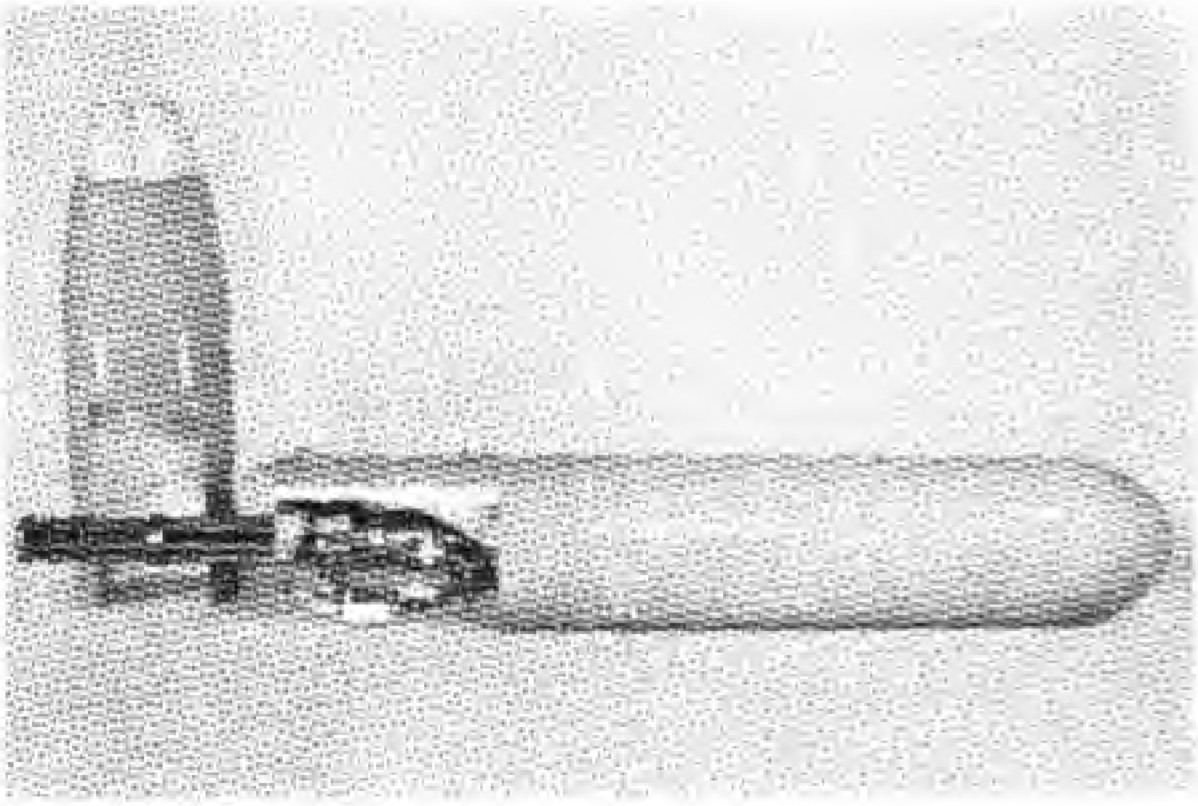
One system was used by Emerson Electric Company on the XM28 turret on the AH-1G Cobra. The linked ammo was folded every other round and stored in a drum which had a revolving inner drum with paddle wheel like drives against the folded linked round's projectiles. A single lead helix was used inside the fixed outer drum. As the belted ammo came out of the drum it was unfolded and routed to the gun through flexible chuting. This single ended system was called the MAMEE.

A General Electric experimental feed system used a drum to store linked ammo with the projectiles pointed toward the center of the drum. The inner drum had longitudinal paddle shaped blades that pushed on the linked rounds as they fanned around the inner drum which rotated. The outer drum was fixed and had a smooth inside with a single lead helix so that the linked rounds were forced toward its end as they turned inside with the inner drum. A sprocket on a booster at the end of the helix pushed the linked belt inside a flex chute to the gun. This drum was called the Universal Rotary Ammunition Handling System and was used with the Minigun firing in tests with pintle mounts, and fired at 6000 spm.

A successful Minigun Linked Storage System was used with pintle mounted Miniguns on UH1B's, etc. This system used four tall cans that were clustered together in the center of the HUEY's cargo deck.

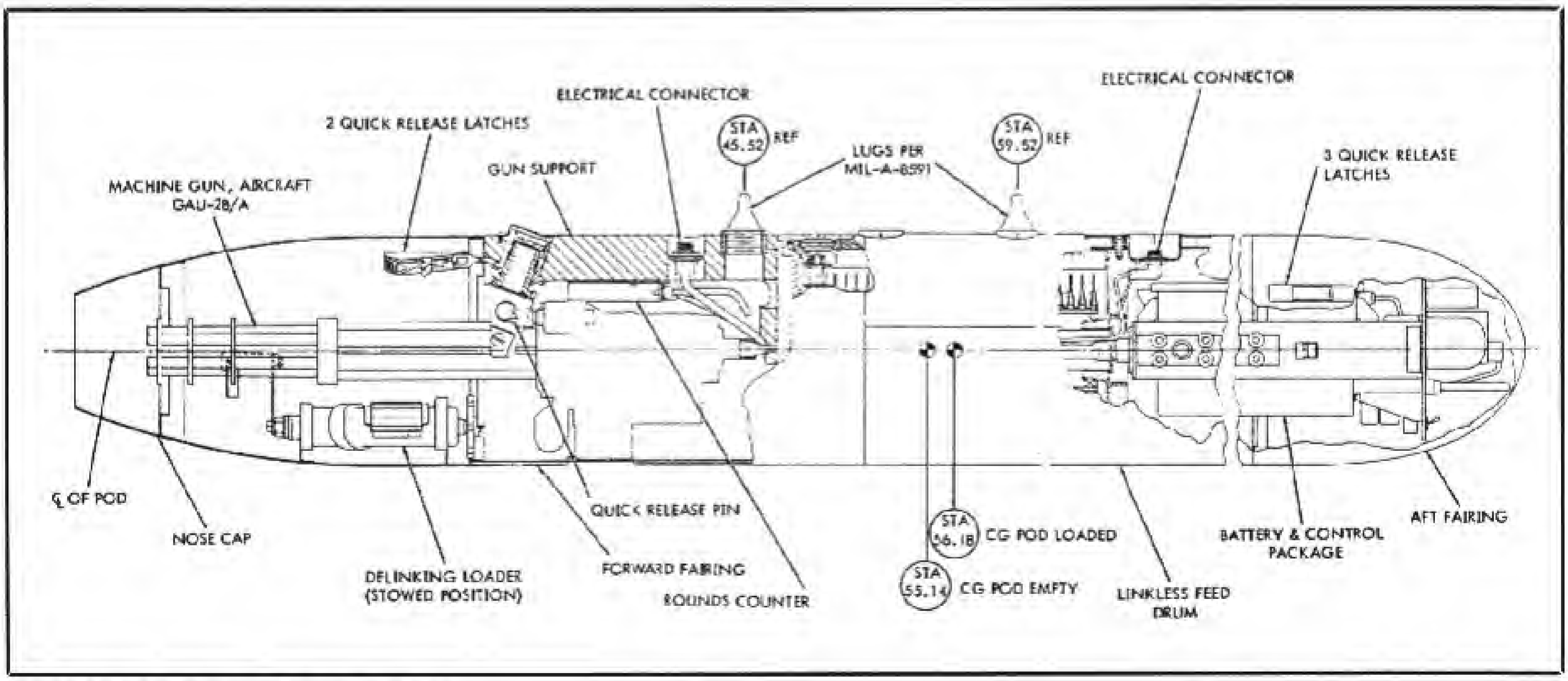


SUU-11A/A 7.62mm Minigun Pod



SUU-11B/A 7.62mm Minigun Pod

A1E with SUU-11/A Pod


ELECTRICAL CONNECTOR
2 QUICK RELEASE LATCHES
STA 45.52 REF
GUN SUPPORT
MACHINE GUN, AIRCRAFT GAU-2B/A
LUGS PER MIL-A-8591
STA 59.52 REF
ELECTRICAL CONNECTOR
3 QUICK RELEASE LATCHES
℄ OF POD
NOSE CAP
DELINKING LOADER (STOWED POSITION)
QUICK RELEASE PIN
FORWARD FAIRING
ROUNDS COUNTER
STA 56.18 CG POD LOADED
STA 55.14 CG POD EMPTY
LINKLESS FEED DRUM
BATTERY & CONTROL PACKAGE
AFT FAIRING

SUU-11B/A 7.62mm Minigun Pod

Each can was just thick enough to allow the belted rounds to fit inside. The can was loaded with ammo starting on the bottom and flaking back and forth over each other a length of about twelve rounds until the ammo built up to the top of the can. The belt then went to the bottom of the next can being flaked in the same manner as the first can. The four cans were loaded as such with one continuous belt using a crossover on the end of two adjacent cans. A hood (like an inverted funnel) was placed over the four cans with the ammo feeding up through the center of the hood. A booster was located there, and picked the belt ammunition up from each can in turn. This arrangement worked well up to and over 4000 spm since it avoided sliding the belts horizontally over each other causing extra loops, "S" curves and jams as the loops would approach the exit of the cans.

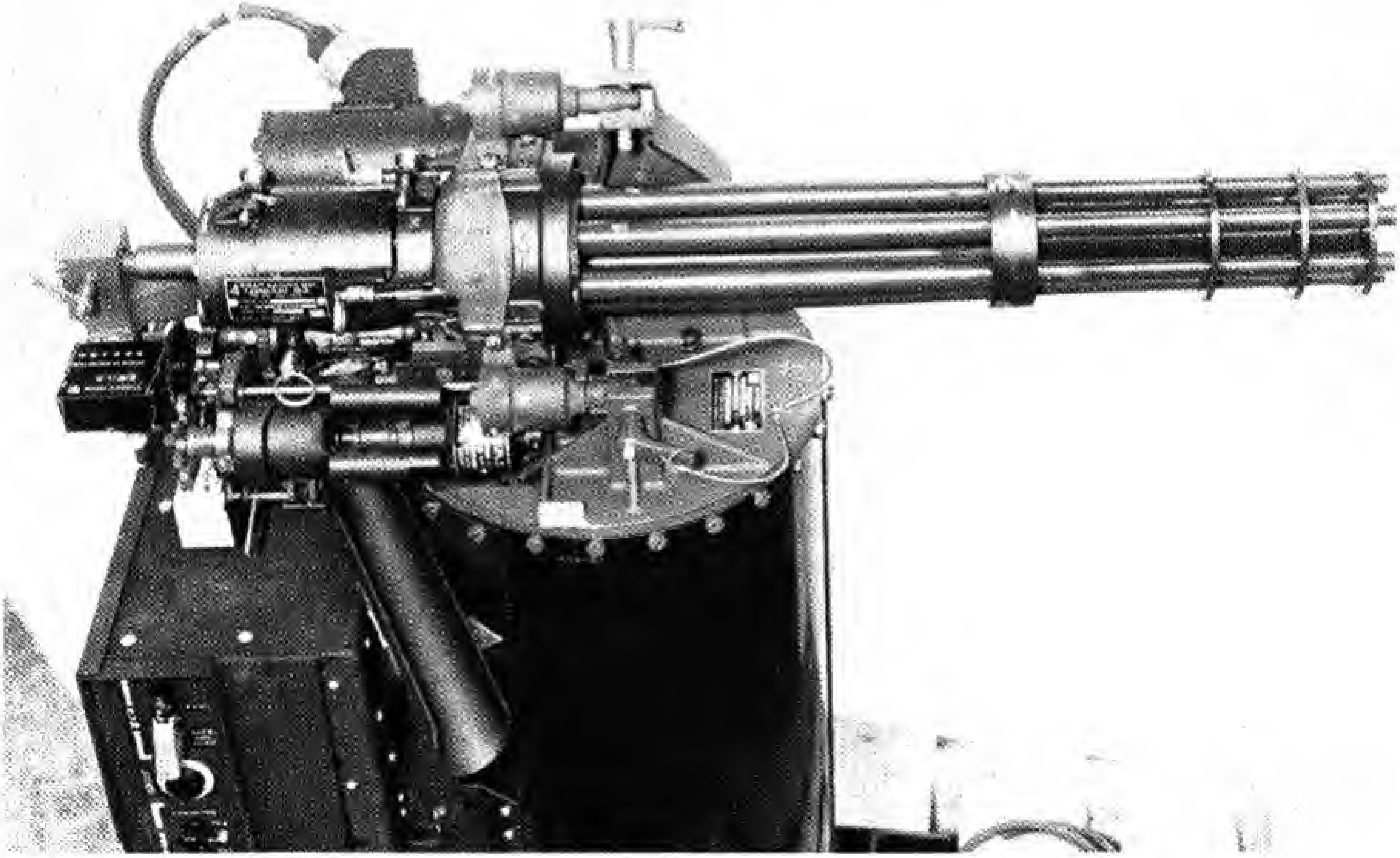
Mini-Pod SUU-11A/A (XM18E1)

The Mini-Pod was the first Minigun installation and started in production at General Electric in 1965.

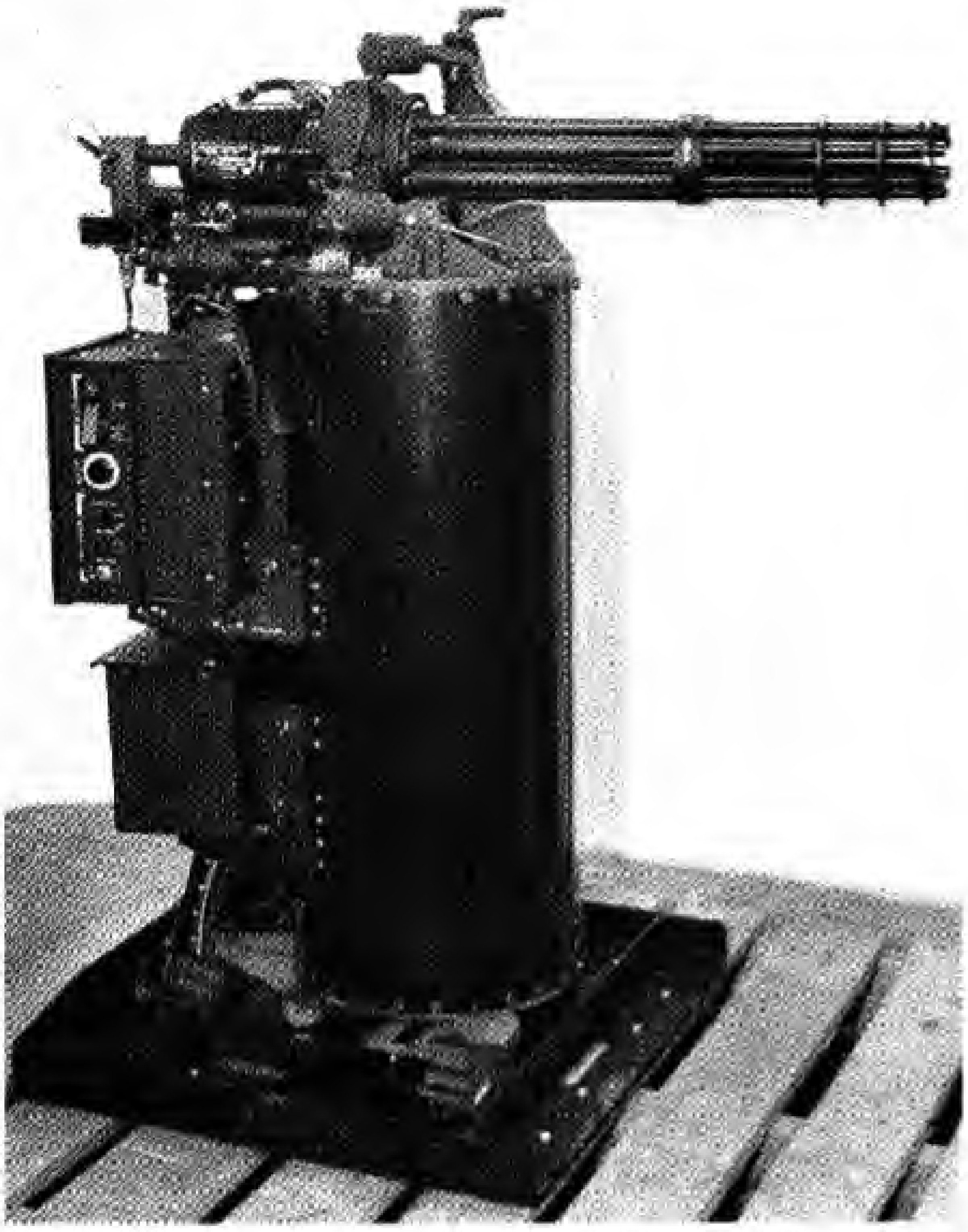
It was first used in Southeast Asia on the AC-47 "Puff-the-Magic-Dragon" which was the first of the

Characteristics

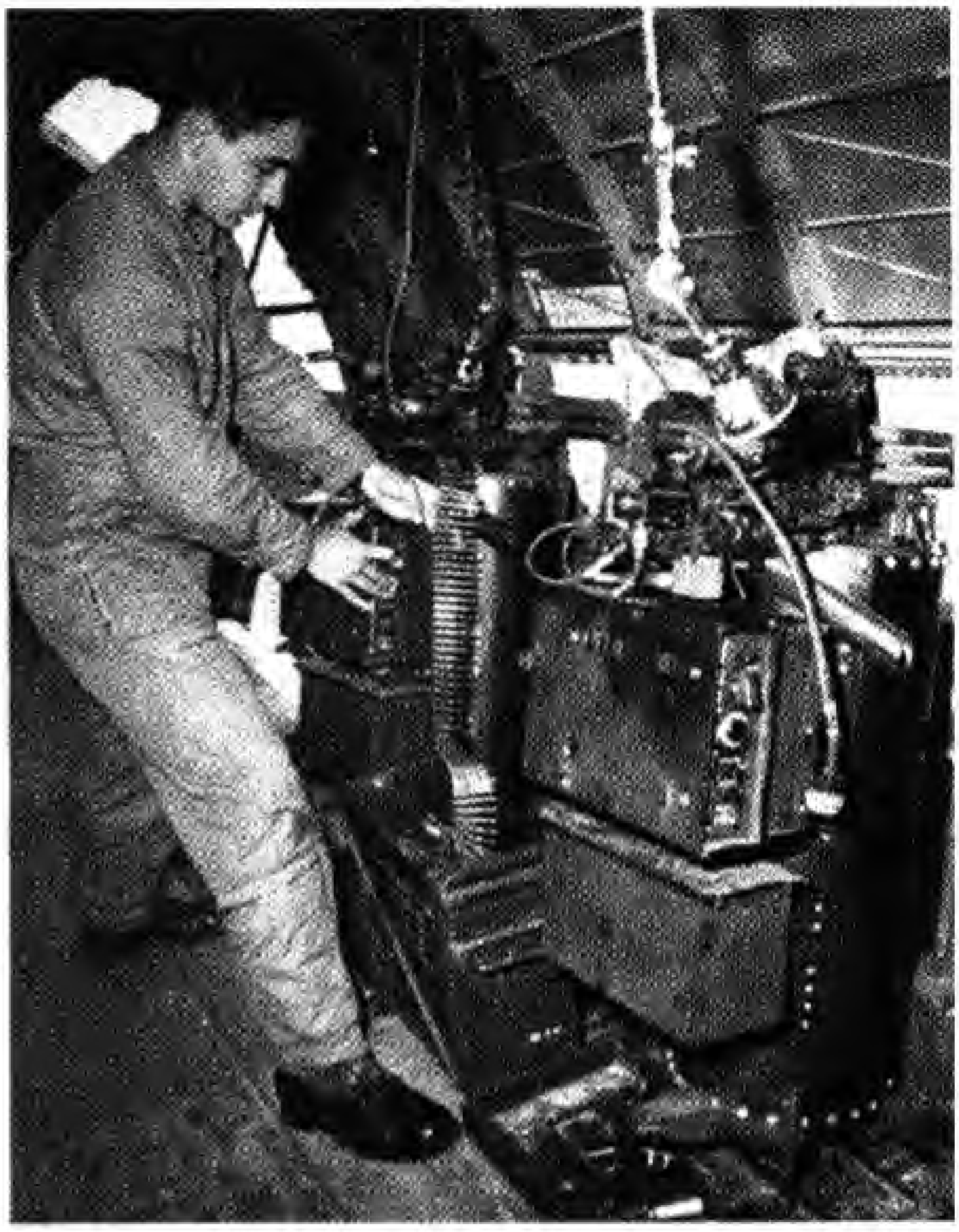
Components:	
Gun	GAU-2B/A, 7.62mm NATO
Feed	Linkless Ammunition Feed System
Drive	22vdc. Electric Drive
Firing Rate	3000 and 6000 spm other rates available
Ammunition Capacity	2000 rds
Weight (without Cradle and Base assemblies weighing 35 lbs.)	
Loaded	294 lbs.
Empty	185 lbs.
Loading	Self-contained power loading (Hand power loading alternate)
Control Power	28vdc, 15 Amps
Clearing	Automatic after each burst
Boresight Adjustment	+1½° azimuth elevation
Dispersion	8 mils, 80% circle - Hard Mount (Variable dispersion obtainable)
Recoil Forces:	
Average at 6000 spm	300 lbs.
Peak at 6000 spm	600 lbs.
Mean Rounds to Failure	50,000 rds (estimated)



GAU-2B/A 7.62mm Aircraft Machine Gun - MXU-470 Module



GAU-2B/A 7.62mm Minigun and Feed System



MXU-470 Module 8G195-2

"Side-Fire" gun ships. It fired out the port windows at ground targets while the aircraft flew pilon turns around the target.

The Mini-Pod was also extensively used as an externally-stored gun pod on both high and low performance aircraft. The pod carries 1500 rounds of 7.62mm ammunition which is fired at 6000 spm.

It utilizes the Minigun GAU-2B/A and a one-way Linkless Feed System. A battery pack located in the rear ogive powers the gun so that only control voltage and a trickle battery recharge voltage are required from the aircraft.

Reloading the pod is done without the aid of special ground support equipment. Back-loading is accomplished with belted standard M13 links and an on-board hand crank.

A unique wheel conveyor transports the rounds from the storage drum exit to the Miniguns feeder. By-pass clearing is used as a solenoid controlled gate is opened in the feeder during gun coast down at the end of the burst. Rounds are discarded overboard so that the gun is free of all ammunition as it comes to a stop.

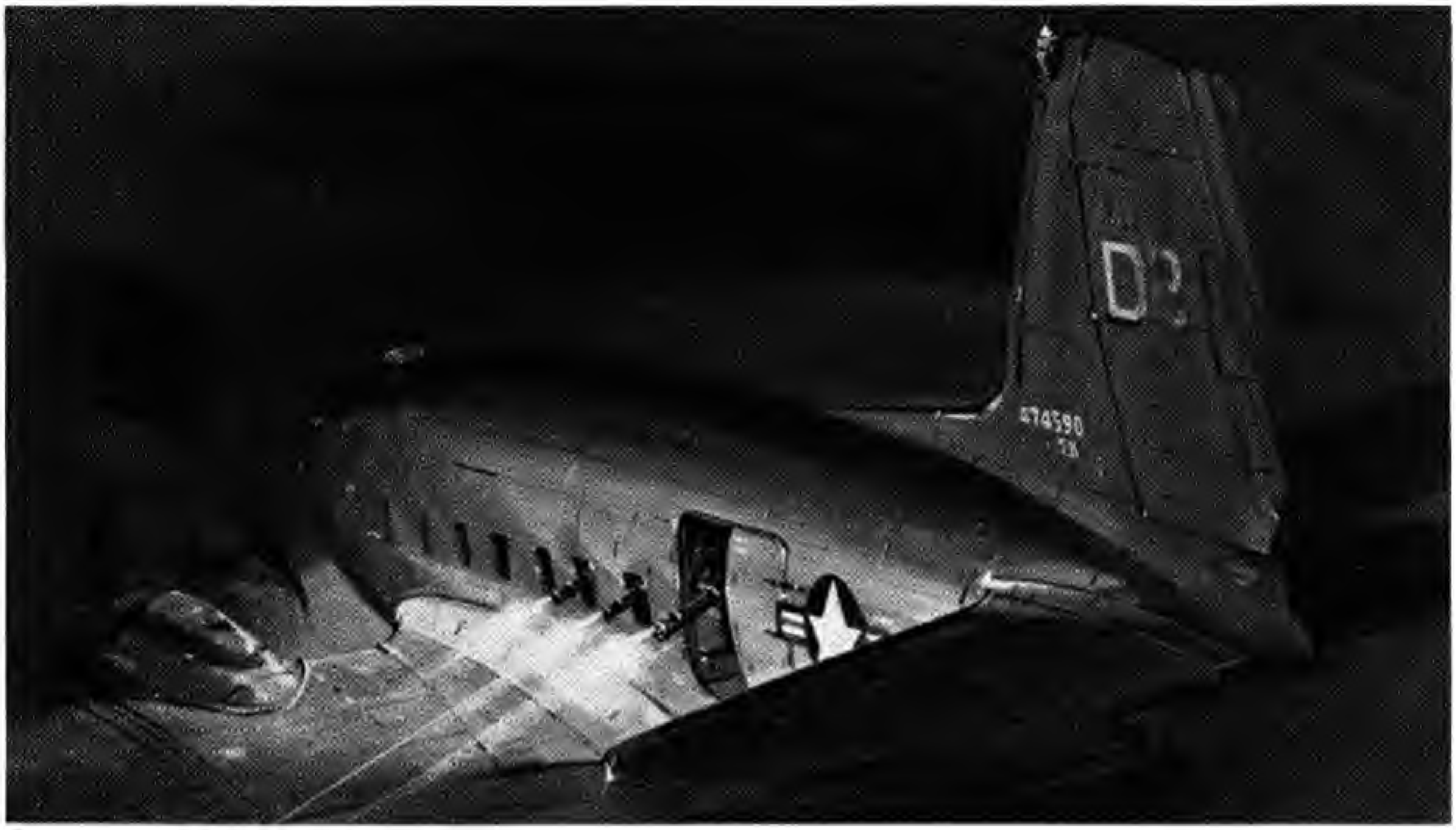
A solenoid controlled clutch has been installed on some pods to achieve clearing without discarding rounds. This clutch stops the feeder during gun coast down so that ammunition does not enter the gun and it stops empty of rounds, fired cases, etc.

Modifications have allowed a 3000 spm firing. A large longer drum containing 3000 rounds of ammunition was designed into an experimental Mini-Pod and successfully tested.

Minigun Module - 7.62mm - MXU-470/A. As firing intensified in Southeast Asia around 1965, it became apparent that the Mini-Pods used in the AC-47 gun ships, although performing well, took a lot of room inside the aircraft.

A new Minigun system called the "Module," the MXU-470/A, was created. It was a simplified one ended linkless feed drum that was vertical, with the Minigun mounted horizontally on top of the drum so that it was just the right height to fire out the windows of the AC-47.

The module started in production in General Electric in 1966. The drum holds 2000 rounds of 7.62mm ammunition, and the gun fires at either 3000



Miniguns in "Puff"

First Produced SUU-11/A Minigun Pods Firing From AC-37 Side Fire spm or 6000 spm.

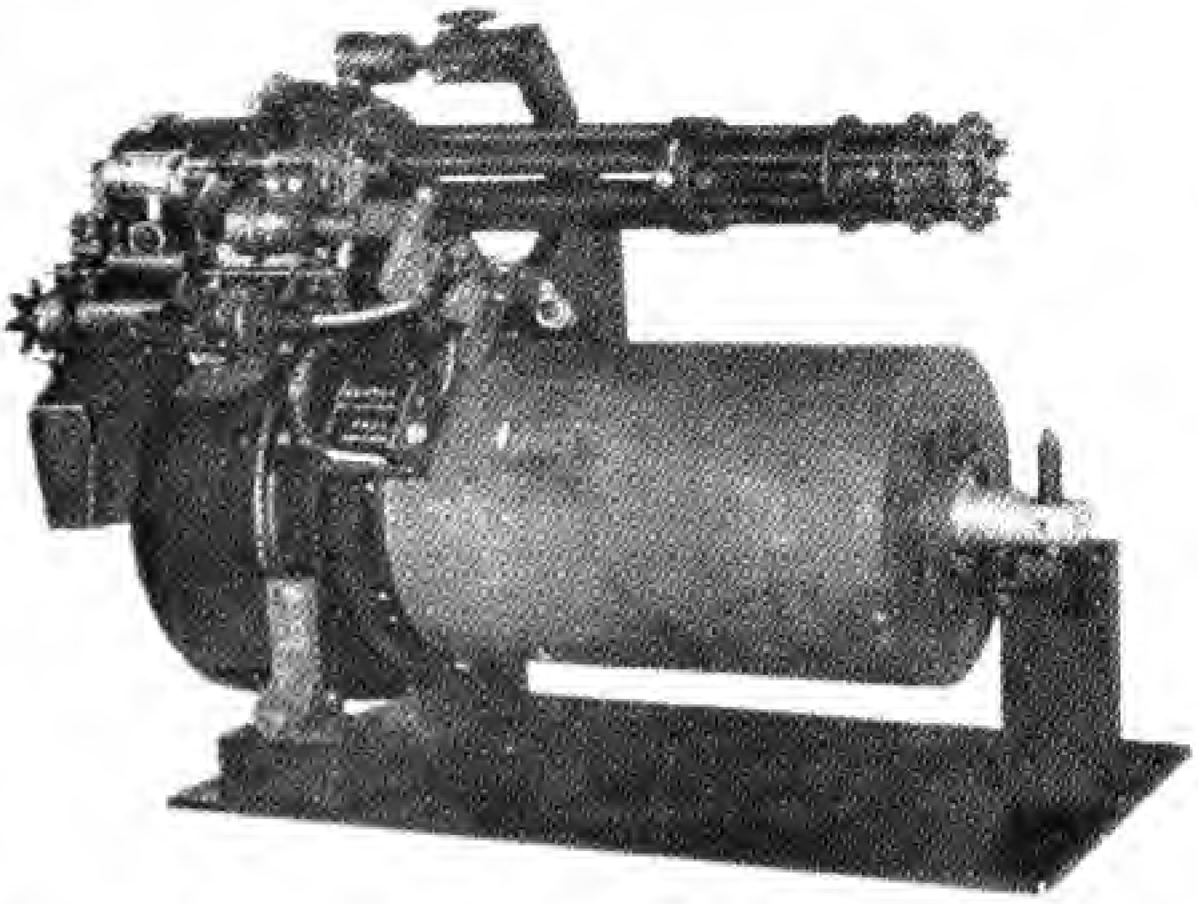
The Minigun is driven by self-contained batteries that only required control and trickle charge voltages from the aircraft.

The drum is back-loaded with a built in power loader that takes extra belted ammunition stored on board, delinks it and stores the rounds in the drum at any convenient time such as a lull in the mission for topping-off the drum. By-pass gun clearing is provided by the feeder during gun coast down.

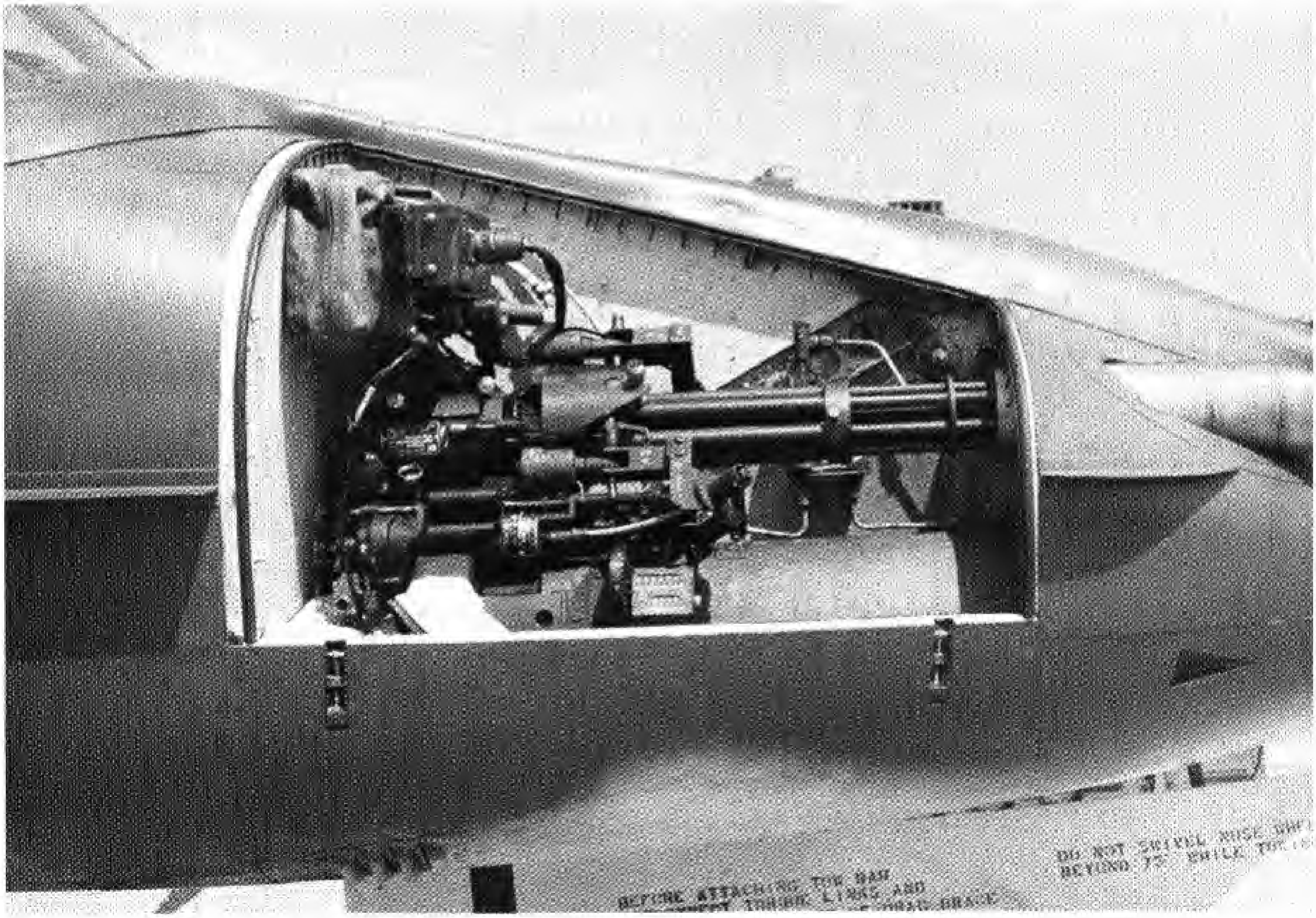
The drum has a three point mounting to a base plate. The base plate is secured to the deck of the aircraft. The three point mounting allows the module and gun to be boresighted in harmony with the pilots sight.

The Minigun module was also incorporated in the armament systems of the two other "Side-Fire" aircraft, the AC-119 and the AC-130.

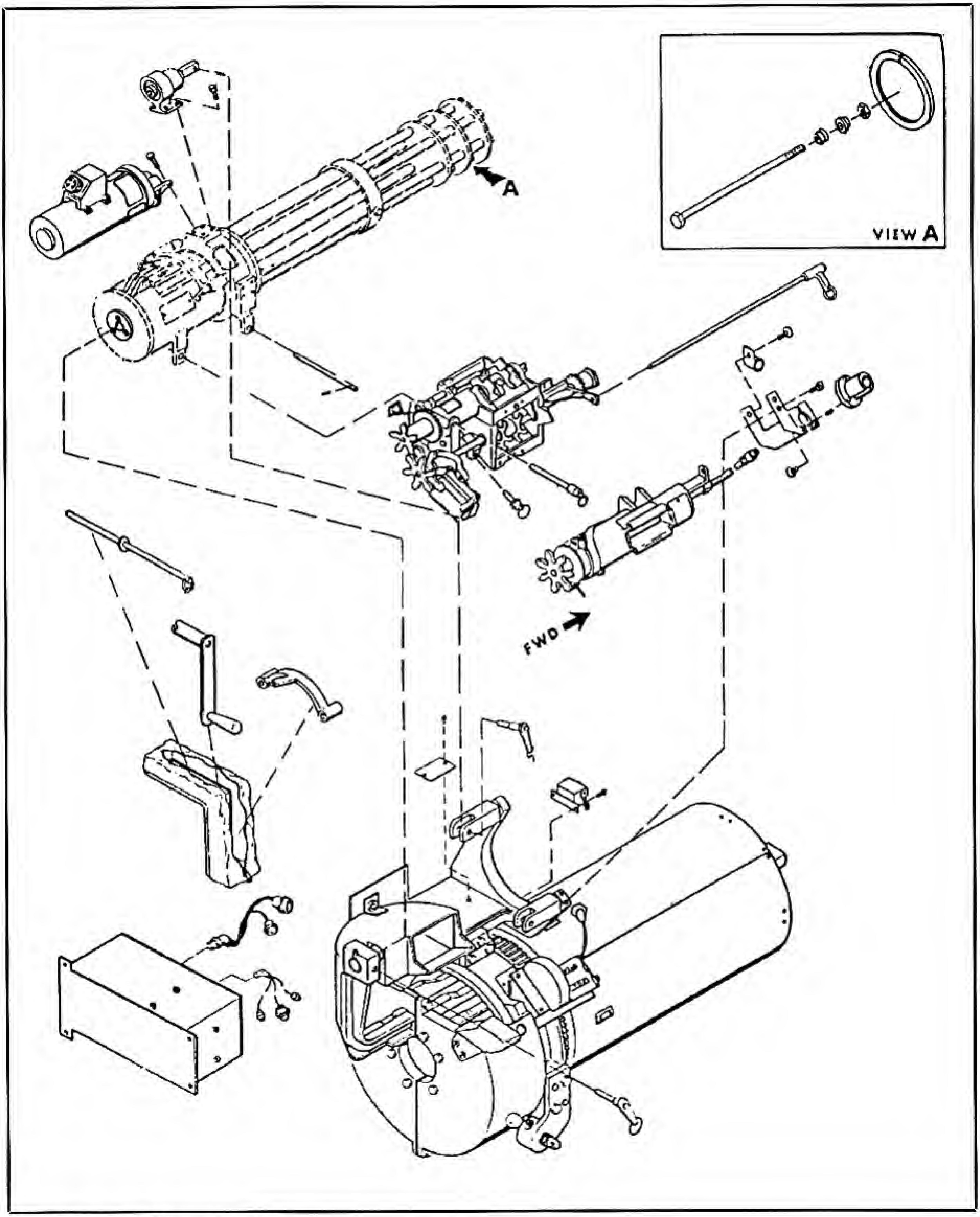
Aging Air Force Douglas C-47 transports were armed with three newly-designed General Electric 7.62mm. Miniguns with a combined rate of fire of 18,000 rounds/minute were deployed in South Vietnam in the role of long-endurance strike fighters.



7.62mm Minigun Internal Aircraft Assembly



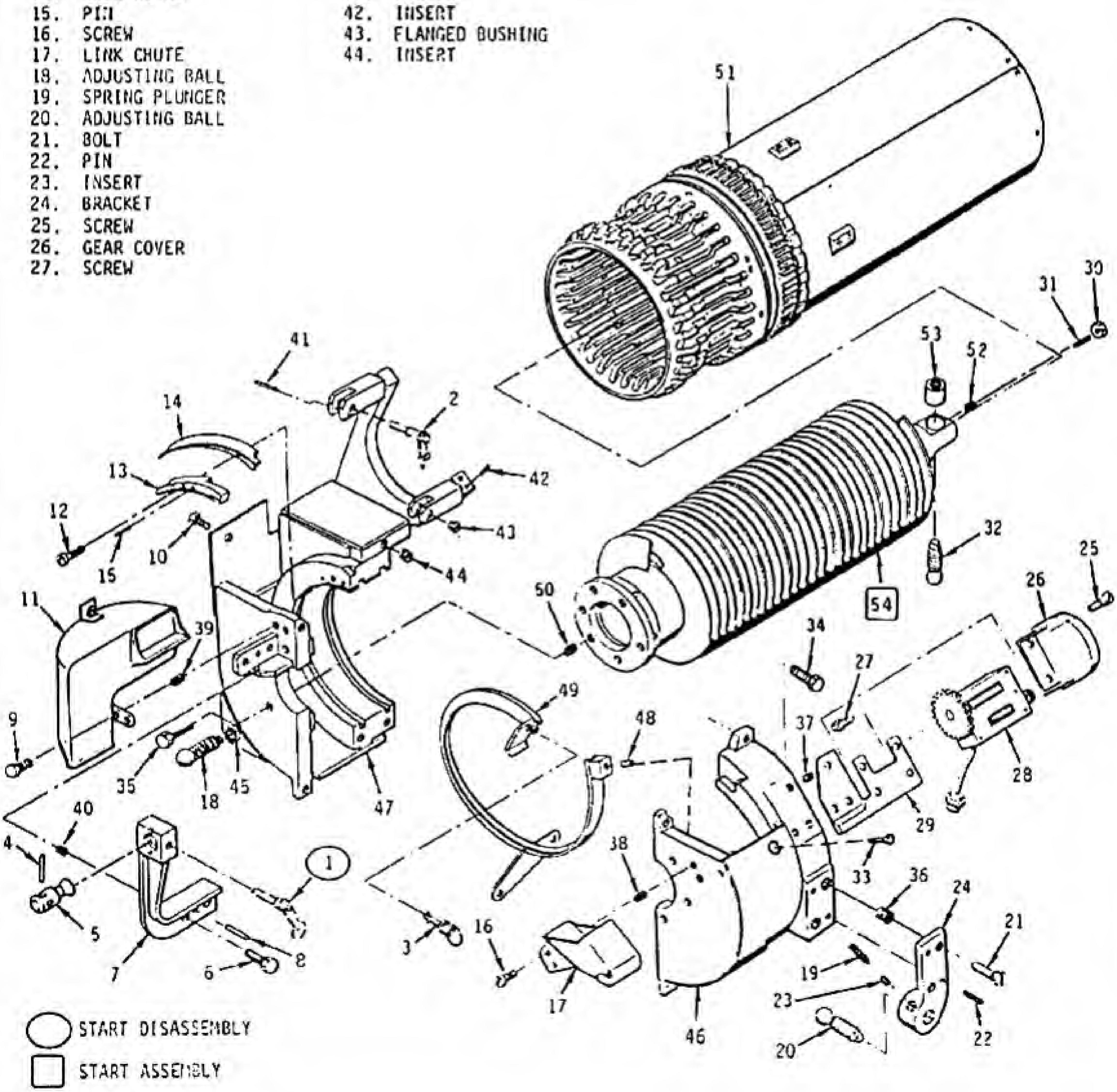
Minigun On-Board the AT-370



Feed and Storage Drum Assembly

LEGEND

1. QUICK-RELEASE PIN (REF)
2. QUICK-RELEASE PIN (REF)
3. QUICK-RELEASE PIN (REF)
4. PIN
5. GUN BALL
6. BOLT
7. AFT GUN ARM
8. PIN
9. BOLT
10. BOLT
11. EJECT CHUTE
12. SCREW
13. NOSE CAM
14. NOSE GUIDE
15. PIN
16. SCREW
17. LINK CHUTE
18. ADJUSTING BALL
19. SPRING PLUNGER
20. ADJUSTING BALL
21. BOLT
22. PIN
23. INSERT
24. BRACKET
25. SCREW
26. GEAR COVER
27. SCREW
28. ROUNDS COUNTER
29. COUNTER BRACKET
30. NUT
31. SPRING PLUNGER
32. ADJUSTING BALL
33. BOLT
34. BOLT
35. BOLT
36. INSERT
37. INSERT
38. INSERT
39. INSERT
40. INSERT
41. PIN
42. INSERT
43. FLANGED BUSHING
44. INSERT
45. INSERT
46. RIGHT HALF SUPPORT (MATCHED)
47. LEFT HALF SUPPORT (MATCHED)
48. INSERT
49. MAIN ROUND GUIDE
50. INSERT
51. OUTER DRUM ASSEMBLY
52. INSERT
53. THREADED BUSHING
54. INNER DRUM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○ START DISASSEMBLY

□ START ASSEMBLY

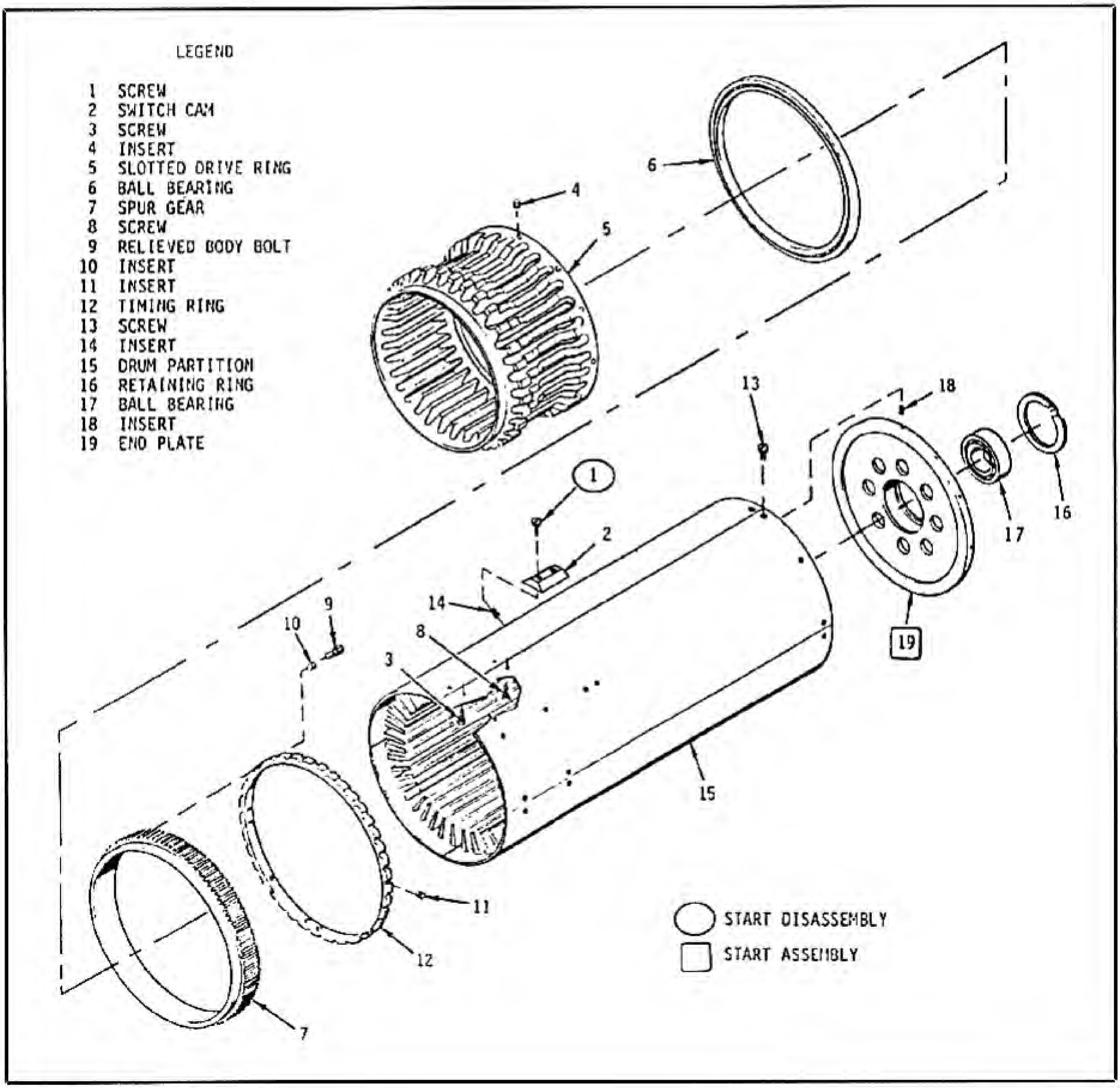
Feed and Storage Drum Assembly

The AC-47, dubbed "Puff, the Magic Dragon" because of the noise and rate of fire of the Miniguns, normally flies at an altitude of 2,500-3,000 ft., well above the range of most small arms fire from the ground.

The 7.62mm Minigun, based upon the principles of GE's M61 20mm Vulcan gun, has a basic weight of 35 lbs., with a design life of 100,000 rounds. Overall length is 31.5 in. Rate of fire can be varied from 300 to 6,000 rounds/minute.

Puff is a pre-World War II C-47 that someone with imagination outfitted with three gatling-type miniguns capable of delivering broadsides at 18,000 rounds per minute of 7.62mm bullets, tracer or standard.

The guns all point at 90 degrees from the line of flight and deliver the kind of broadsides John Paul Jones would have understood much better than a Korean jet or ace or veteran of the jet strikes in North Vietnam.


LEGEND
1 SCREW
2 SWITCH CAM
3 SCREW
4 INSERT
5 SLOTTED DRIVE RING
6 BALL BEARING
7 SPUR GEAR
8 SCREW
9 RELIEVED BODY BOLT
10 INSERT
11 INSERT
12 TIMING RING
13 SCREW
14 INSERT
15 DRUM PARTITION
16 RETAINING RING
17 BALL BEARING
18 INSERT
19 END PLATE
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○ START DISASSEMBLY
☐ START ASSEMBLY

Outer Drum Assembly

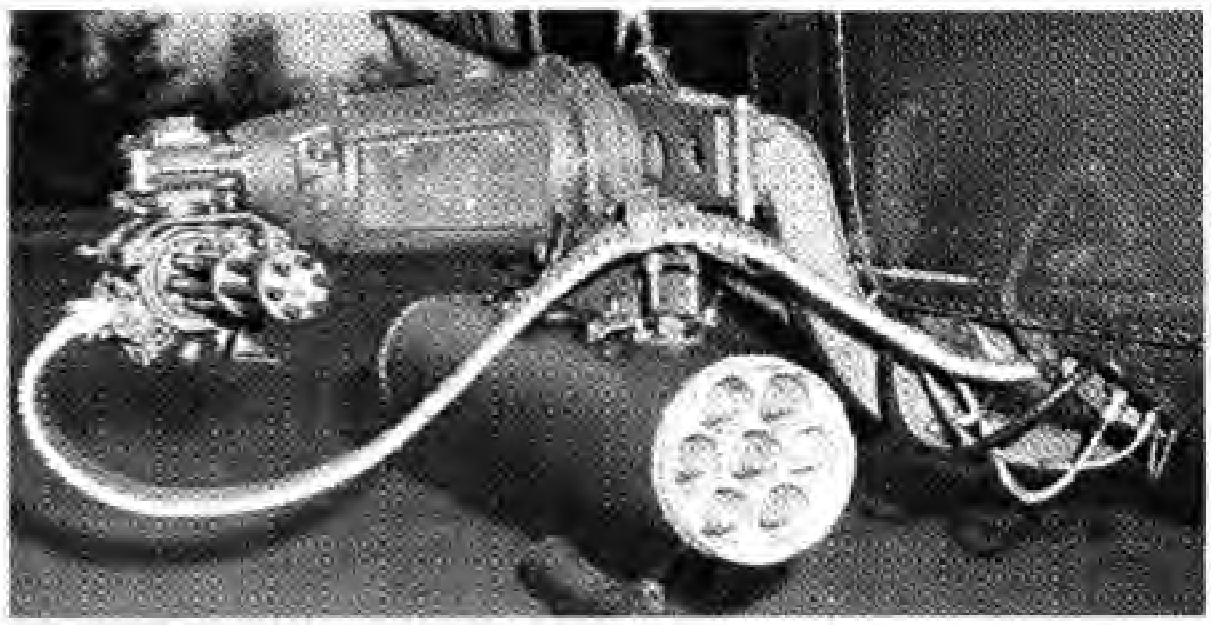
Characteristics

Components:	
Gun	GAU-2/A Minigun
Feed	MAU-59/A Linkless
Drive	Electric or Gun Gas
Length (as installed in AT-37D)	33.5 in.
Width (as installed in AT-37D)	16.7 in.
Height (as installed in AT-37D)	22.4 in.
Weight (as installed in AT-37D):	
Loaded	220 lbs.
Empty	140 lbs.
Ammunition	7.62mm
Firing Rate	Variable up to 6000 spm
Ammunition Capacity	1500 rds.
Maximum Burst Length	Full linkless feed complement (1500 rds)
Dispersion	6.5 mils, 80% circle (Hard Mount)
Recoil Forces:	
Average	300 lbs.
Peak	600 lbs.
Case Ejection	None, captured in container beneath assembly
Link Ejection	None, links removed during loading
Reliability	25,000 rounds per malfunction
Maintainability:	
Loading	Automatic, utilizing ammunition belted in M13 links, hand crank power
Gun Removal	3 quick-release fasteners
Removal of Assembly from Aircraft	Less than 15 minutes
Special Tools	None

Primarily an anti-personnel weapon, Puff circled a beleaguered outpost while the pilot lined up the target in a gunsight pointed out of the left window. Flying at 122 knots, he fired while keeping the left wing low and the piper (illuminated sighting image) on the target. The AC-47 flies at about 3,000 feet, works mostly at night and did not come up against anti-aircraft gunners willing to face her murderous fire.

Capable of circling long hours over a beleaguered fort or outpost, Puff can start the deadly circle quickly and in three seconds cover an area the size of a football field with at least one bullet to every square foot.

In all, five puffs went through the original test. Later, twenty sisters, in immaculate brown and green camoflage paint, arrived to strengthen the force.



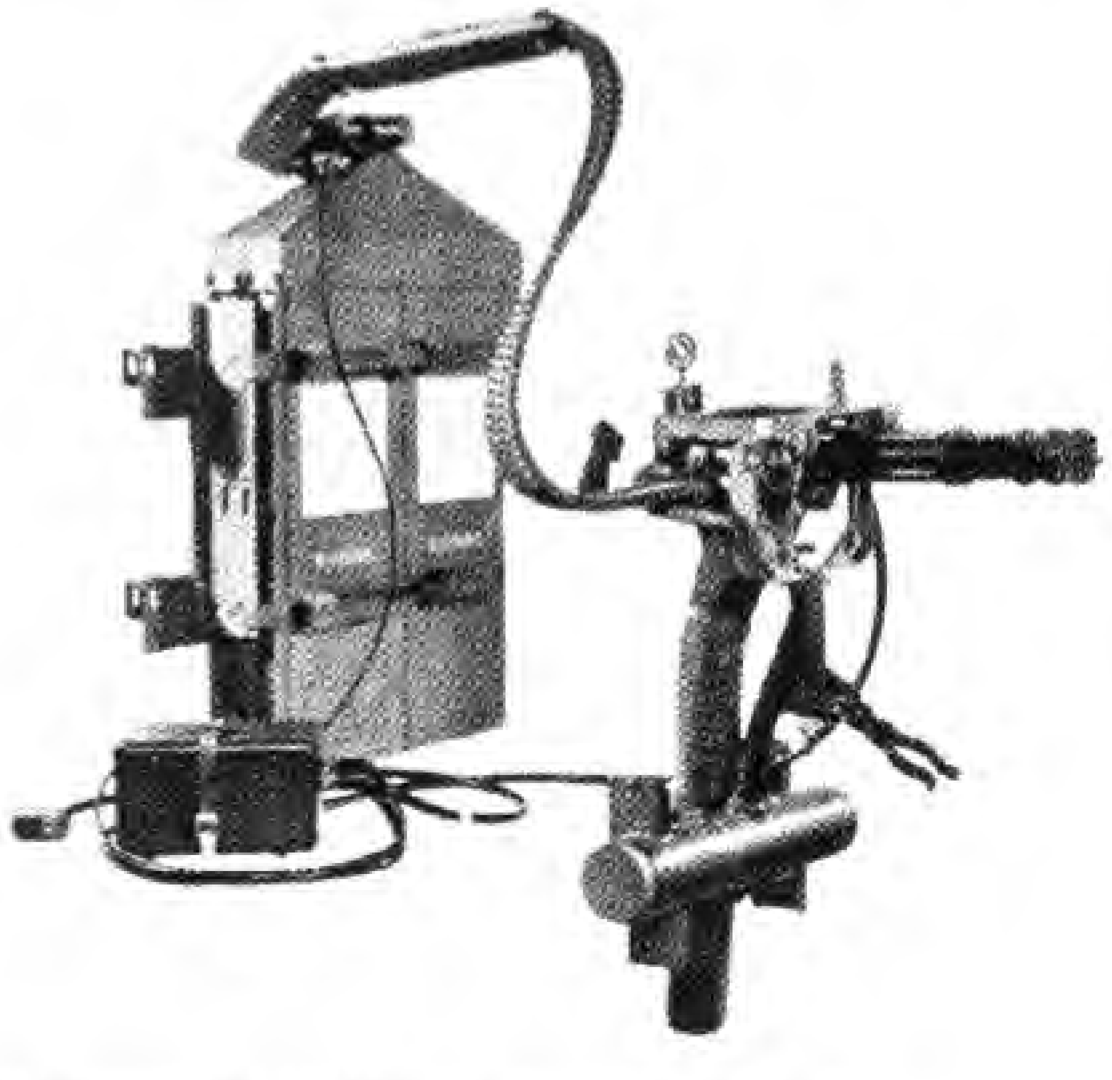
Armament Subsystem, Helicopter, 7.62mm High Rate Gun/2.75" Rocket Launcher XM21 (Right Side View)

The name traces back to one of the first AC-47 missions when the guns were loaded with all tracer ammunition. Government troops were panic-stricken by the tongues of fire that they saw licking over the ground after Viet Cong.

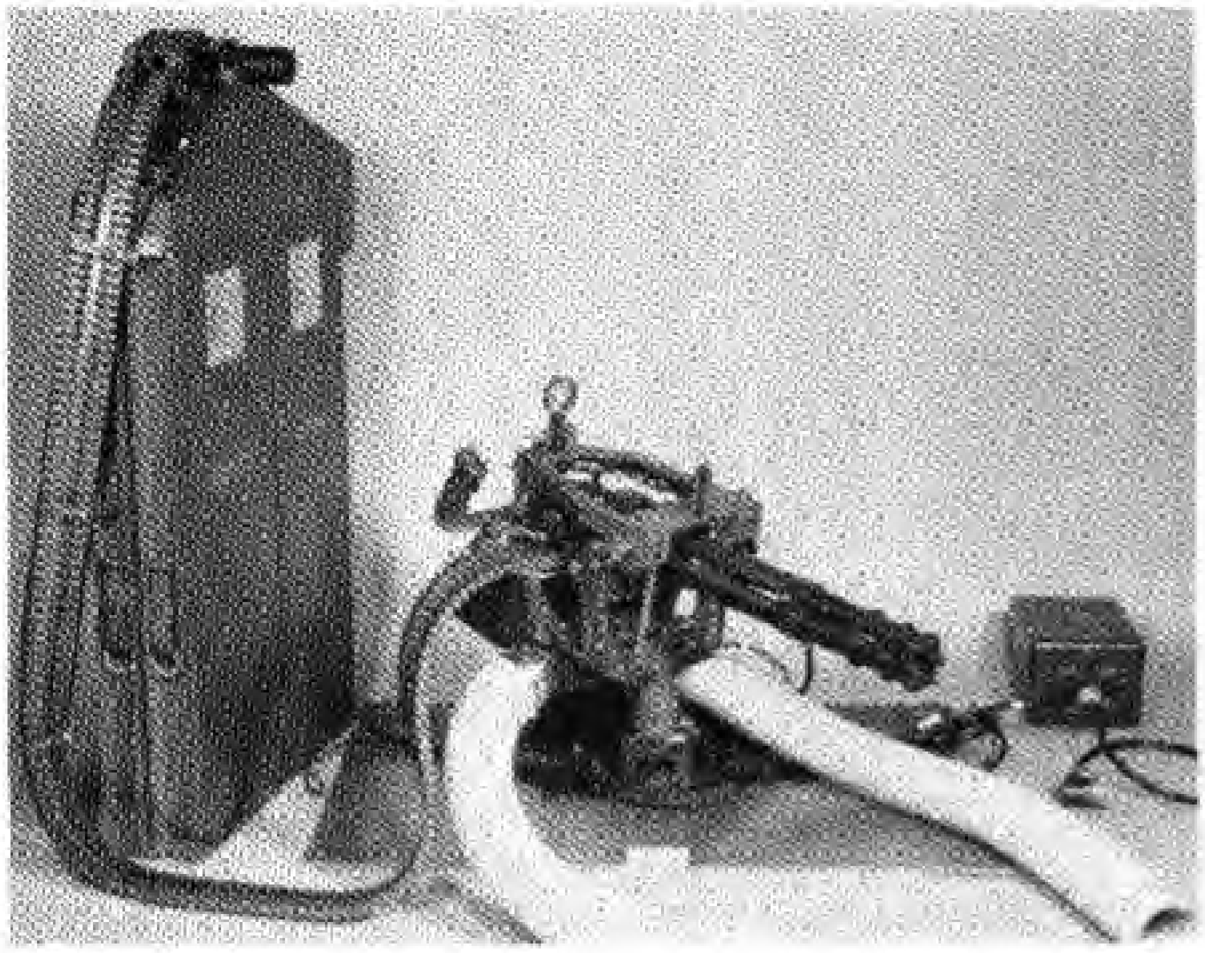
Calling the plane a dragon, the troops were virtually on the point of breaking and running. Their United States advisers calmed them with assurances that the dragon was friendly, if magic.

Minigun on the AT-37D. The Minigun 7.62mm GAU-2B/A was installed in the nose of the U.S. Air Force AT-37D using a singular-modular self-contained unit, that started in production by General Electric in 1967.

A new one way Linkless Feed System was designed, and it laid horizontal in the nose directly



UH-1N and UH-1H Helicopter Configuration



UH-1N Helicopter Configuration

under the Minigun. The outer drum of this system rotated about the fixed inner drum. The outer drum had fixed longitudinal slots that rotated all the ammo about the inner helix, driving the ammo to the end of the helix. Here a rim guide captured each round, changing the round orientation from radial to the drum to being parallel to it. The outer drum moved the rounds along the rim guide.

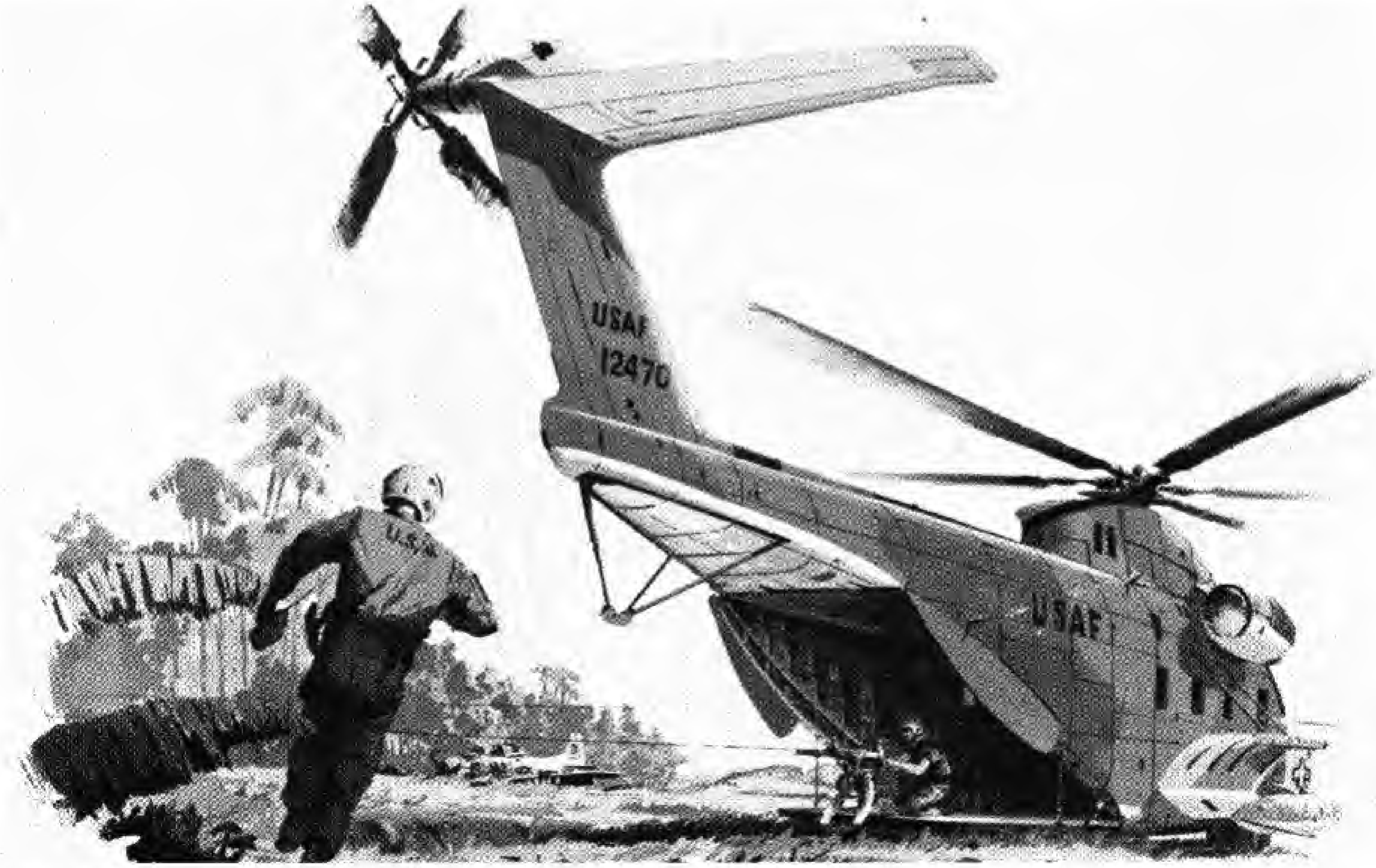
At the end of the rim guide the round entered the Minigun's feeder from which it was passed to the gun and fired. All spent cases and duds were discarded from the gun to a storage bin below the drum. The drum could be back-loaded with linked ammo using a built in loader and handcrank carried in the aircraft. The drum held 1500 rounds, and the Minigun fired at 6000 spm.

Gun clearing was provided by a by-pass in the feeder that was opened by a solenoid during gun coast down.

A three point mounting of the modular system permitted boresighting of the complete system when installed inside the nose of the aircraft.

A special muzzle defuser was designed to break up the gas pattern and the flash to keep from hindering the pilots vision, and to help keep gun gas out of the engine scoops.

Minigun Subsystem on UHIB. The Minigun was installed on the UHIB Helicopter armament subsys-



HH-53 Helicopter

HH-53 Helicopter

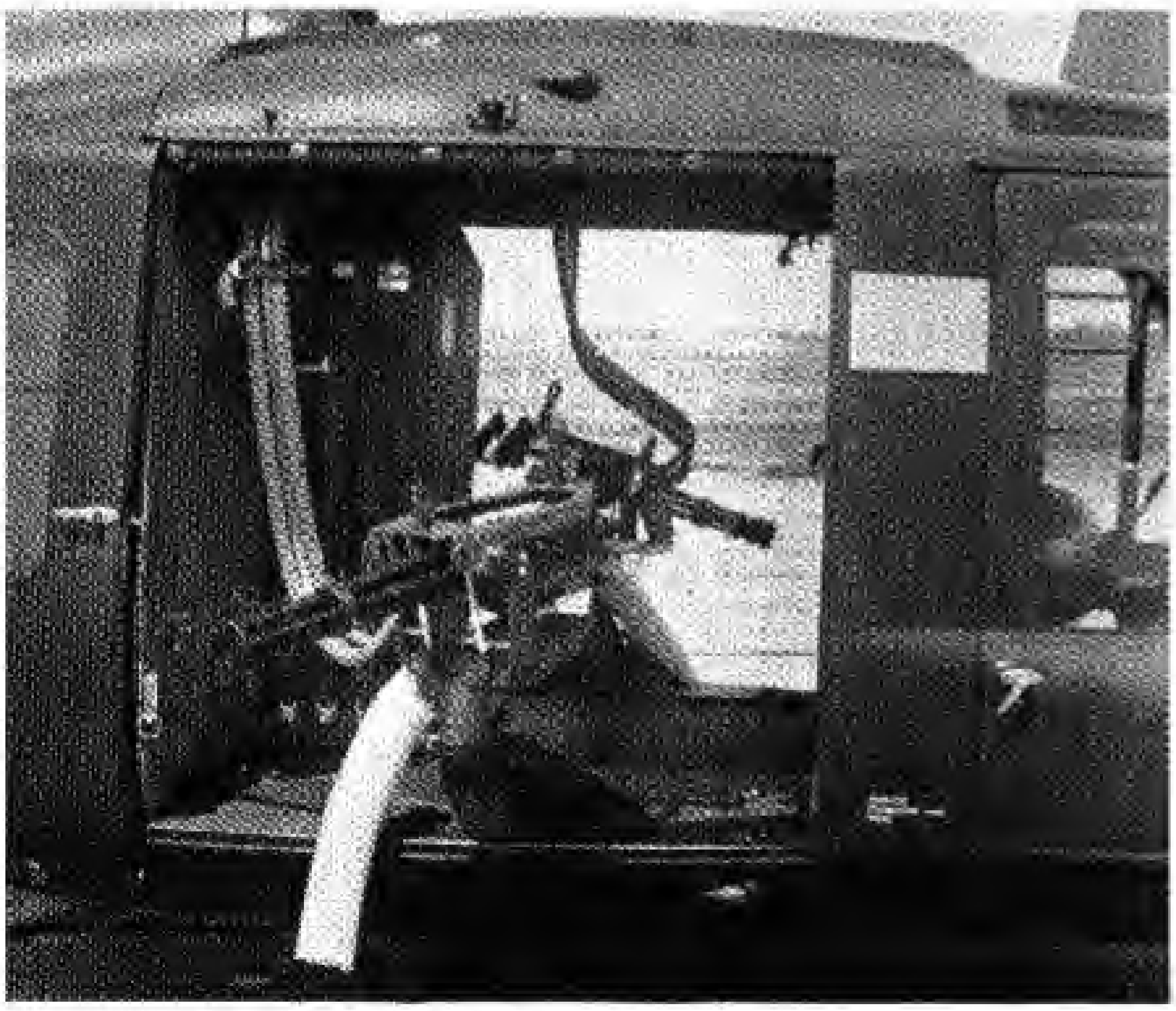
tem XM16 and redesignated the XM21. This design was completed by Springfield Armory and G.E. and used in SEA.

Two Miniguns were used, one on each side of the helicopter. The ammo was stored under the troops seats requiring a booster for each side. The spent brass was ejected overboard. Standard M13 links were used to make up the ammo belt.

The firing rate was selected by the pilot or the gunner to be within 2000 spm or 4000 spm.

The gun was cleared after each burst using the clearing/delinking feeder.

The turret drive was hydraulic and could point the Minigun device slightly up, and somewhat outboard and down.



7.62mm Minigun in Helicopter Mount

Characteristics

Gun	M134, GAU-2B/A, 7.62mm
Weight (with gun and ammunition):	
External Configuration	1070 lbs. (5200 rds./gun)
Internal Configuration:	
XM93	1176 lbs. (5200 rds./gun)
XM93E1	1376 lbs. (6000 rds./gun)
Firing Rate	Selectable, 2000 or 4000 spm
Ammunition Capacity (2 gun stations)	10,400 or 12,000 rounds
Feed System	Linked ammunition belt
Drive System	Electric
Power Requirements:	
Starting (max.)	28 vdc, 400 Amps
Steady State	28 vdc, 100 Amps
Ammunition	NATO 7.62mm
Barrel Life	100,000 rounds
Reliability	60,000 MRBF
Scheduled Maintenance	60,000 rds.
System Life	1,500,000 rds.
Gun Life	1,500,000 rds.
Acceleration Time	0.5 seconds
Deceleration Time	0.25 seconds

7.62mm Minigun Pintle Systems on UH-1N Helicopters. Mounted on the A/A49E-3 mount, the external 7.62mm Minigun pintle configuration is mounted in either or both alcoves of the UH-1 series helicopter, allowing the main cargo area to be free for other mission requirements (i.e., troops, cargo, stretchers, etc.).

This configuration is presently used by the U.S. Marine Corps on its UH-1N helicopters. The mount will also accept the M60 machine gun and the M2 calibre .50 machine gun.

The ammo boxes are made up of four individual tall rectangular cams with a cross over hood on top. A booster is used on top the crossover. The ammo belt is linked with the M13 link.

The internal 7.62mm Minigun configuration (M93 or M93E1) is mounted in the helicopters cargo bay area. Stowed inside the UH-1 series helicopter, the gun can be quickly pivoted outboard into a firing position. The guns can be fired in the pintle mode by the gunner or by the helicopter pilot in the fixed-forward-firing mode. This configuration is used by the U.S. Air Force on its UH-1N and UH-1H helicopters. The mount will also accept the XM129 40mm Grenade Launcher or the M2 calibre .50 machine gun.

XM27E1

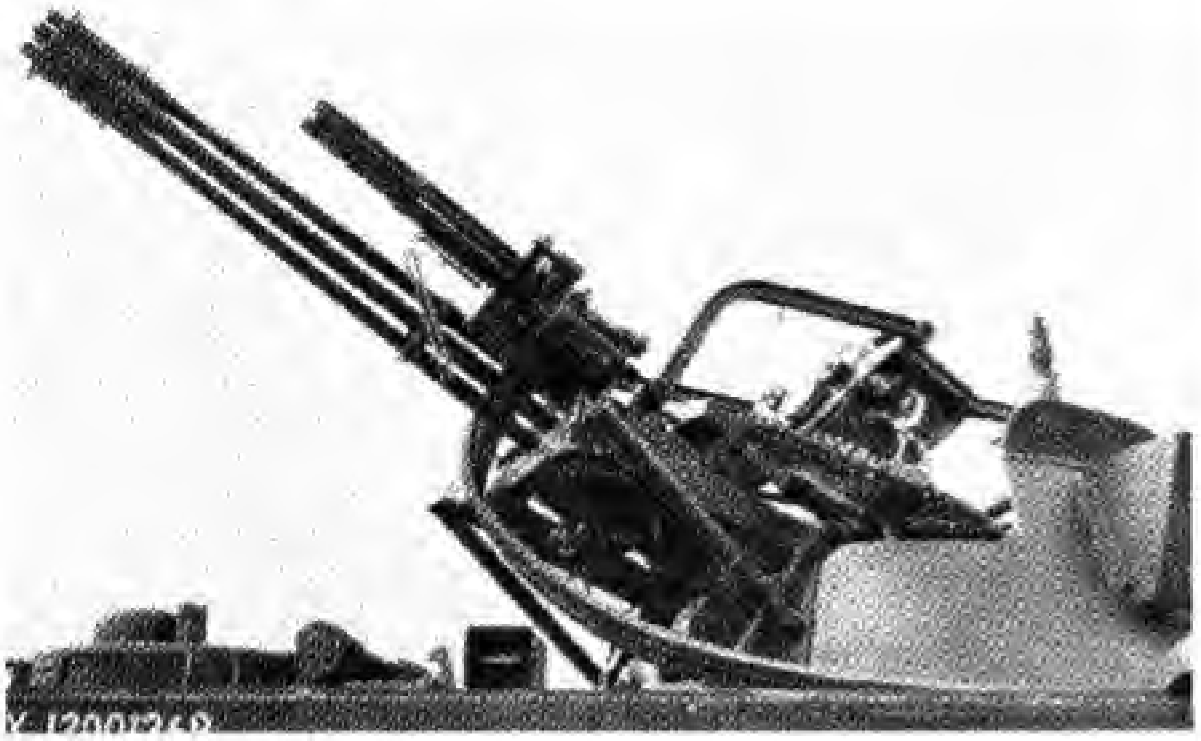
Floor Plan-External Pintle System. The system is mounted in either or both rear alcoves, leaving the forward cargo area free for other mission requirements.

These systems have been proven to be highly reliable and effective in combat enrivonments; the hardware has been in the U.S. Navy inventory since 1969 and the U.S. Air Force inventory since 1970. The pintle-mounted 7.62mm Minigun has also been designed for the SH-3, HH-53, CH-53 and the UH-1F helicopters, in addition to these systems which are used on the UH-1N and UH-1H.

The system is mounted in the cargo bay area providing internal stowage of the gun.

Minigun Turret on the Huey-Cobra (XM28). A two gun turret XM28 was designed and provided by

Vulcan Air Defense System (VADS)

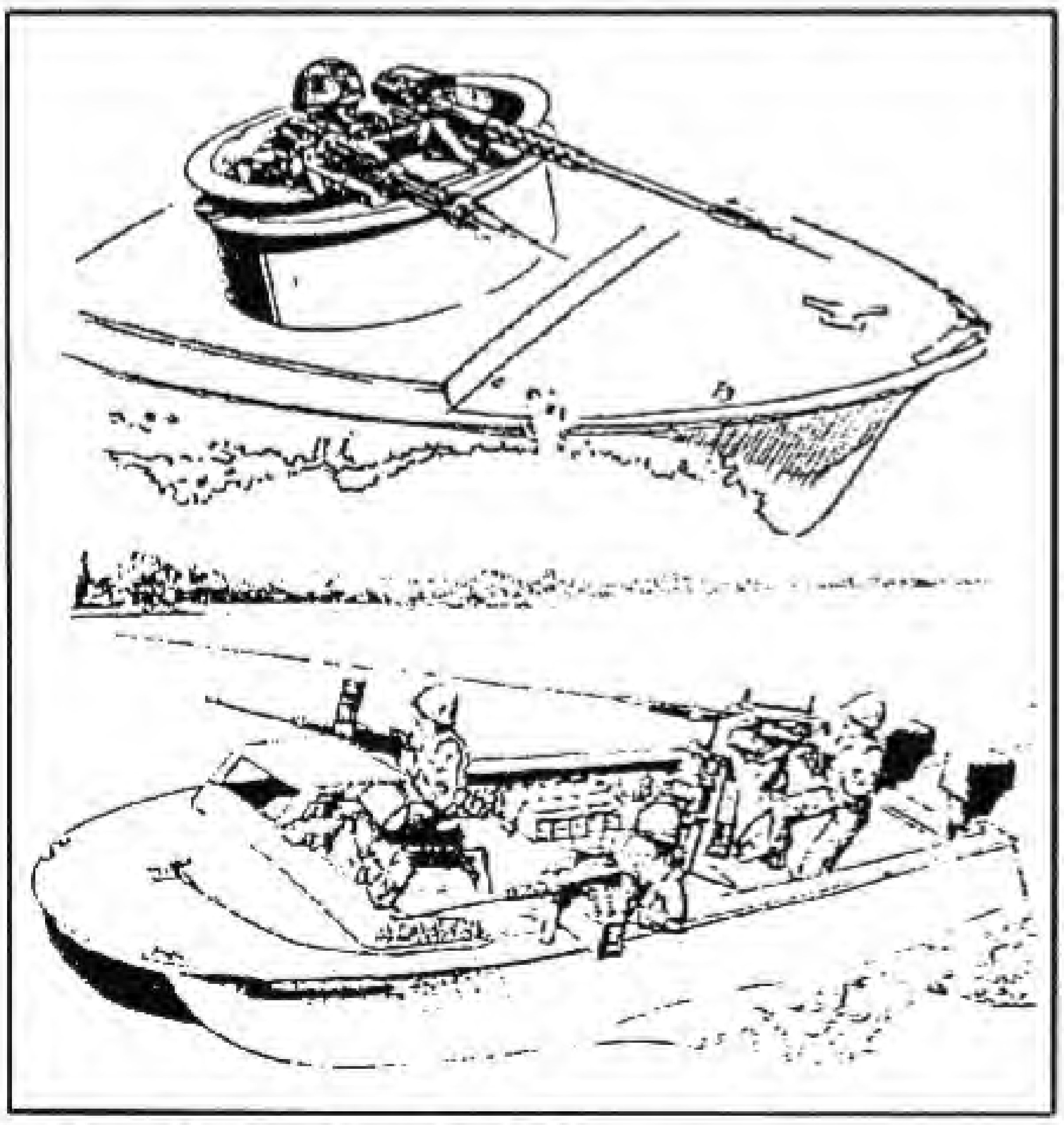


M134 Minigun

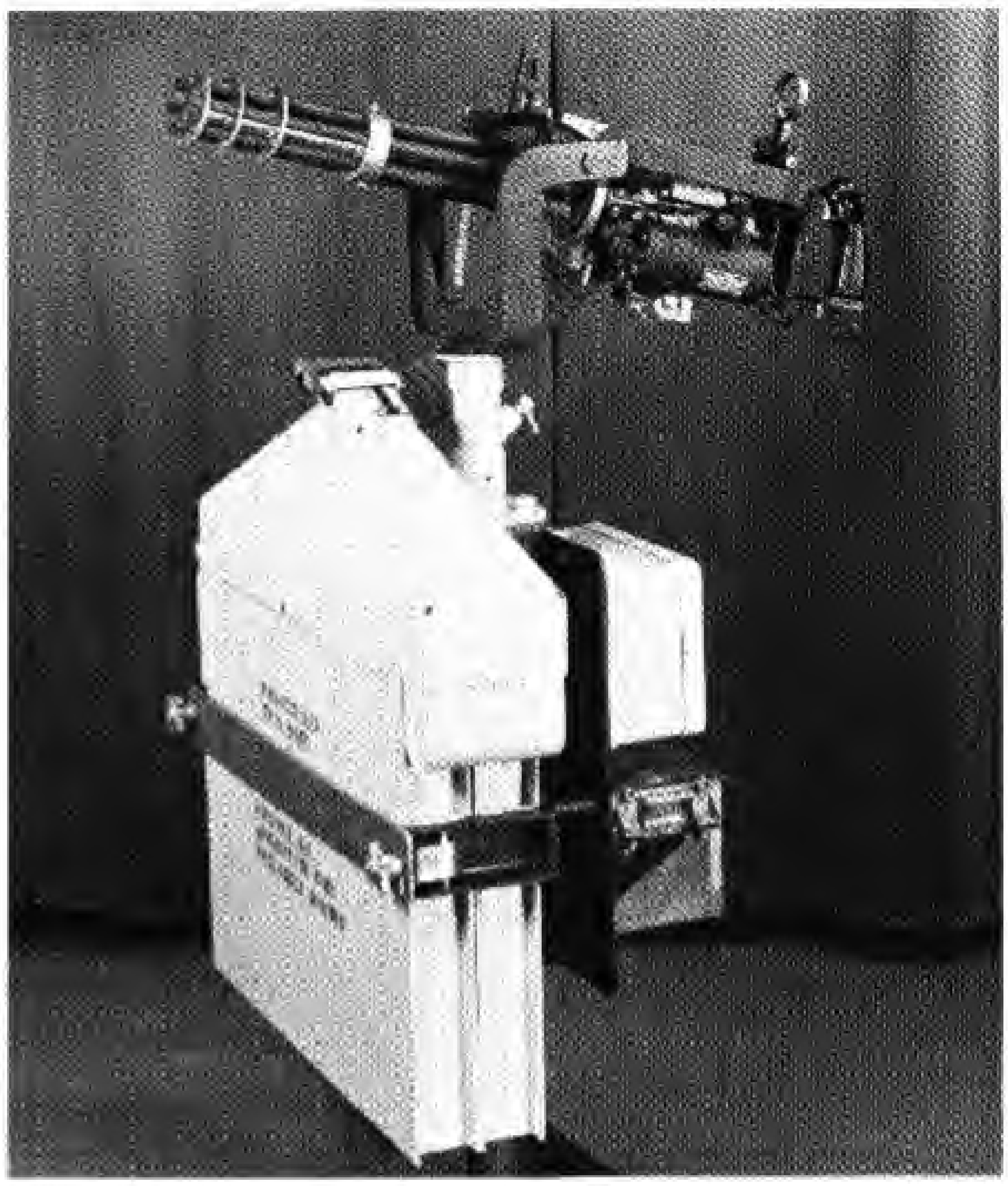
Emerson Electric Company for the Huey Cobra -AH-1G Helicopter. This turret contained two guns, one a Minigun and the other a grenade launcher or two Miniguns.

The turret was located on the chin of the helicopter with its ammo boxes directly behind the turret. Down coverage and some limited up coverage was provided as well as side coverage on both sides.

Ammo links (M13) were used on the Minigun systems ammo belts. A unique drum stored the ammo. The loading unit folded two adjacent rounds on to each other as the rounds entered the drum and they were stored in this fashion. The natural nose fan was reduced by the folding allowing the drum



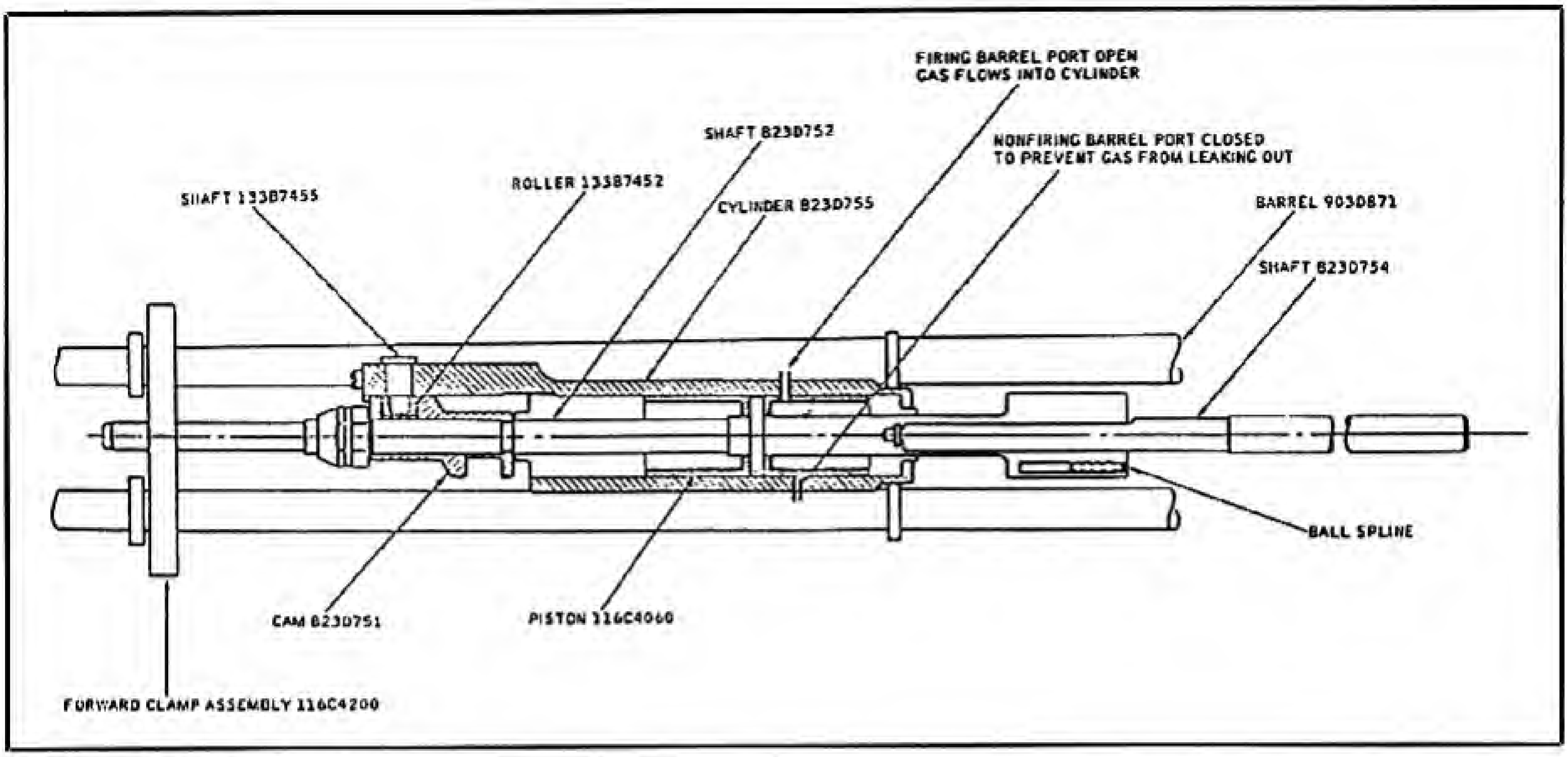
7.62mm Minigun Navy Pintle Mount



7.62mm Minigun

Characteristics

Weight:	
Gun, GAU-2B/A, 7.62mm NATO	35 lbs.
Drive, 22 vdc, Electric Drive 2.5 horsepower	8 lbs.
Recoil Adapter	3 lbs.
Delinking Feeder	10 lbs.
Control Package	25 lbs.
Battery Package	35 lbs.
Saddle Assembly	11 lbs.
Yoke Assembly	11 lbs.
Cables	2 lbs.
Ammunition Container (4000 rounds)	37 lbs.
Chuting	4 lbs.
Brass Disposal Bag	5 lbs.
Mount Assembly	64 lbs.
Total Weight (Less Ammunition)	250 lbs.
Feed System	Linked Ammunition Belt (M13)
Firing Rates	Variable, 1000 to 4000 spm
Dispersion	Hard Mount, 6.5 Mils, 80% circle
Recoil Forces	Average at 4000 spm - 200 lbs. Peak at 4000 spm - 600 lbs.
Coverage	Limited to Boat Interference
Gun Drive	Electric
Ammunition Capacity	4000 rds.



Gas Drive Cylinder Assembly

diameter to decrease. Two thousand rounds were carried.

During firing the inner drum turned and the folded ammo was peeled off tangentially by the exit unit which also served as a booster.

The standard clearing and delinking gun feeder was used with spent cases being ejected overboard. The gun stopped in a cleared condition after each burst.

Up to 4000 spm were fired using the electric drive to provide the power.

Minigun On LOH. The Minigun was designed to function on the LOH helicopter by Hughes Tool Company and the system designated as the XM27 armament system.

This system was able to be mounted into the helicopter as a unit with quick disconnect mountings on the port side of the helicopter.

A linked ammo storage box was used with standard M13 links. The gun was electrically driven and used the clearing/delinking feeder so that the gun was automatically cleared after each burst.

Some down fire was available and limited up fire with firing rates around 2000 spm controlled by the pilot or gunner.

Minigun on Vulcan Air Defense System (VADS). The Minigun system was installed on the VADS-Vulcan Air Defense System to provide a secondary gun for small arms firing for ground to ground missions. It is also used for low-cost training missions for the ground to air modes.

The same Minigun system components for firing belted ammo up to 4000 spm are used on the VADS. Separate controls and feed systems allow either the 7.62mm or the 20mm ammo to be fired.

7.62mm Minigun Navy Pintle Mount. The 7.62mm Pintle Mount is shown here in a configuration specifically for small boat applications.

The 7.62mm Minigun was installed aboard river patrol, coastal patrol and river assault craft either in current gun mounts, such as the Mk 56, or on its own pintle where space permits. Ammunition storage was located on the pintle or in a remote location below decks. The 7.62mm Minigun pintle was powered by its own battery pack, making it independent of boat power except for a small charging current, or it may be powered by the boat's 24 volt DC supply.

Gas Drive Minigun XM133. A gas drive was developed by G.E. for the Minigun XM134. The gun designation with this gas drive was the XM133. This gun was to be used in the XM18 Minigun Pod.

The gas drive was contained inside the barrel cluster. It had a double acting piston that was activated by gun gas through orifices from each barrel. Attached to the piston rod was a cam. The piston and cam were moved backward and forward by the gun gases and were prevented from rotating, being att-

MGST George E. McGarry, USMC (retired) with Minigun Pintle

ached to the rear mount of the gun and keyed to the stationary gun housing.

One roller in the barrel cluster engaged the cam and caused the cluster to rotate as the piston and cam were forced fore and aft.

The cylinder was attached to the barrel cluster in alignment with barrel orifice, and the cylinder rotated with barrel cluster.

An electric motor started was used to rotate the gun from a stopped position until firing started. The motor would then declutch and the gas drive would accelerate the gun to full firing rate.

Firing was stopped by using the clearing device in the de-linking feeder, which by-passed ammo from the gun during gun coast down.

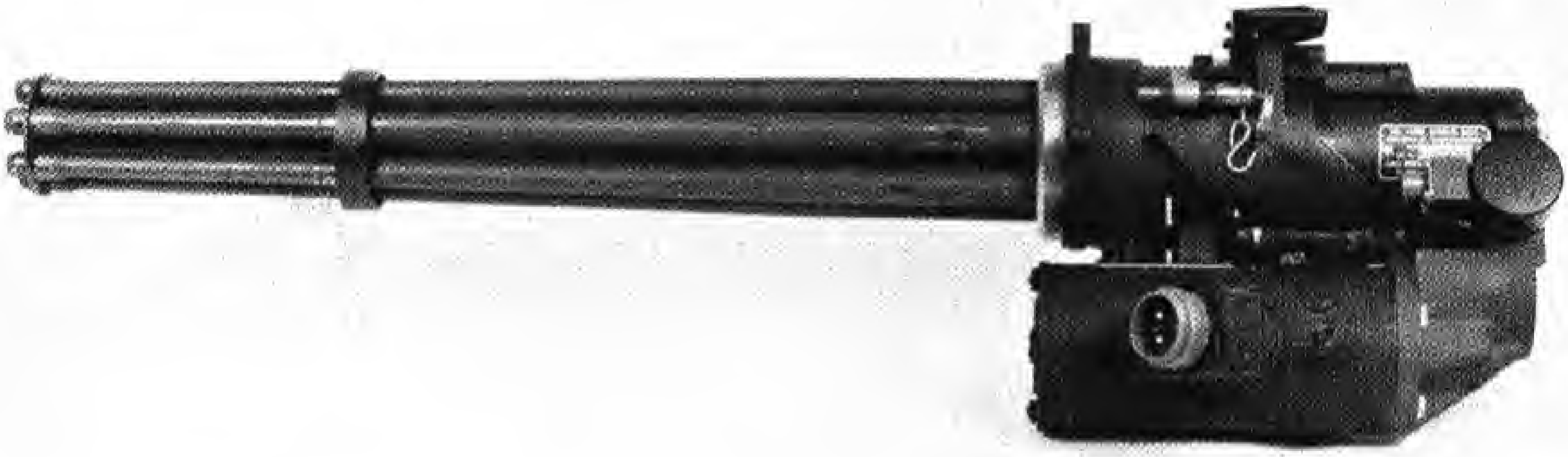
This development was stopped after testing showed that the drive system did not meet maintenance requirements for long life. However, the drive did meet operational requirements of firing at 6000 spm, no minimum burst restrictions (within limits of ammunition supply), and, time to rate not more than 0.3 seconds.

This development was conducted for the Springfield Armory and Eglin Air Force Base during 1965.

Chapter 5

5.56mm XM214 MICROGUN (THE SIX-PAK)

GENERAL ELECTRIC



XM214 5.56mm Microgun

History

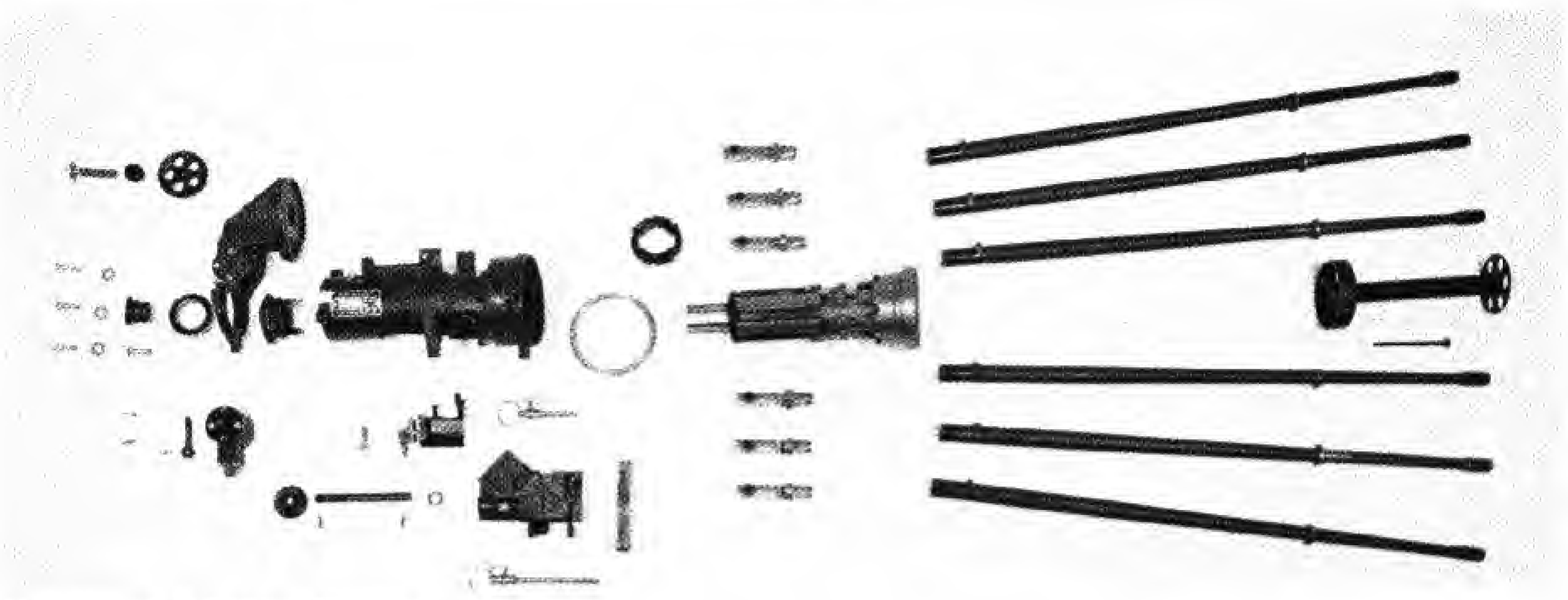
The effectiveness of a lightweight, small-calibre, high rate-of-fire aircraft machine gun was proven in Vietnam by the achievements of the 7.62mm Minigun—most notably in the AC47 "Puff, the Magic Dragon" ships and the Army Huey gunships (XM21). To extend the Minigun's effectiveness, General Electric, under the sponsorship of the military, developed 7.62mm Minigun systems for various light, fixed-wing and rotary-wing aircraft—from internal configurations to hand-controlled pintle arrangements.

In an effort to further extend the effectiveness of such weapons and systems, General Electric Company, with the encouragement of the military, conducted a company-funded design and development program of a 5.56mm Minigun (the 5.56mm ammunition is the same as that used in the tri-service M16 rifle). This weapon represents the third generation Gatling-type weapon produced by General Electric—beginning with the famous 20mm Vulcan gun.

Description

The GE Six-Pak is a self-contained portable weapon system that is mounted on a variety of surface vehicles, aircraft, riverine boats, and ground implacements. The system can fire at selected rates between 400 and 4000 shots-per-minute, and when loaded with 1000 rounds of ammunition weighs less than 85 pounds. The system is divided into two equal carrying loads of approximately 42 pounds each by removing the quick disconnect ammunition packet and chuting.

The system fires standard 5.56mm linked ammunition from 500 round cassettes held in position by an ammunition rack. After the first cassette is emptied



Components of 5.56mm Microgun

within the rack, it can automatically link its first round to the last round of the preceeding cassette. The total ready-rounds are then restored to 1000. These cassettes are factory packaged in disposable containers-eliminating handling of ammunition belts and assuring clean ammunition.

Its mounting versatility and its capability to fire at multiple rates increase mission effectiveness. The weapon neutralizes enemy troops in an area at the low firing rate of 400 shots-per-minute. For a higher hit probability in short time-on-target situations a higher firing rate-up to 4000 shots-per-minute is fired.

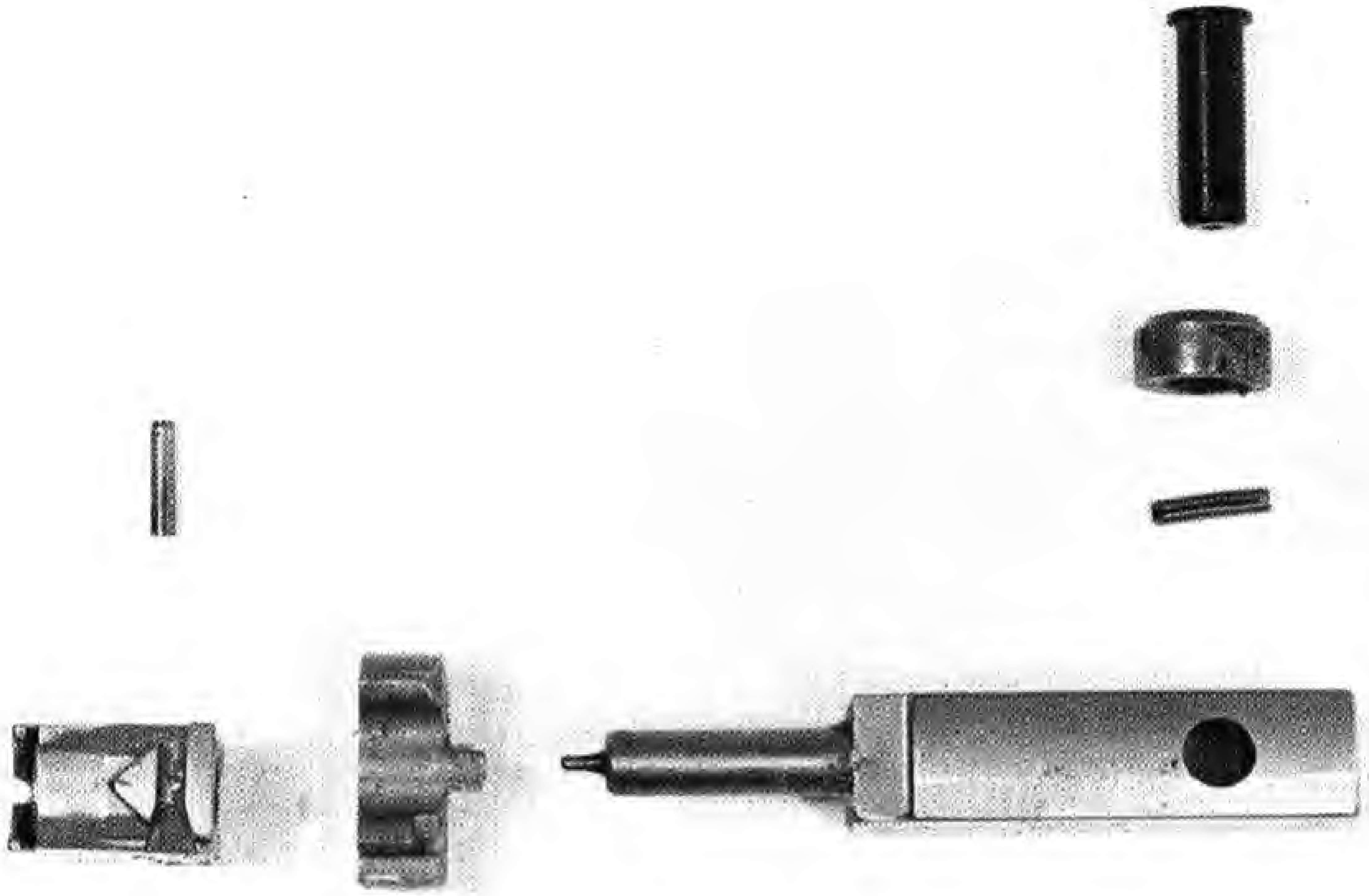
The effectiveness of a lightweight, small-calibre, high rate-of-fire aircraft machine gun has been proven in Vietnam by the achievements of the 7.62mm Minigun.

In an effort to further extend the effectiveness of such weapons and systems, the General Electric Company, under contract with the military, conducted a design and development program of a 5.56mm Microgun.

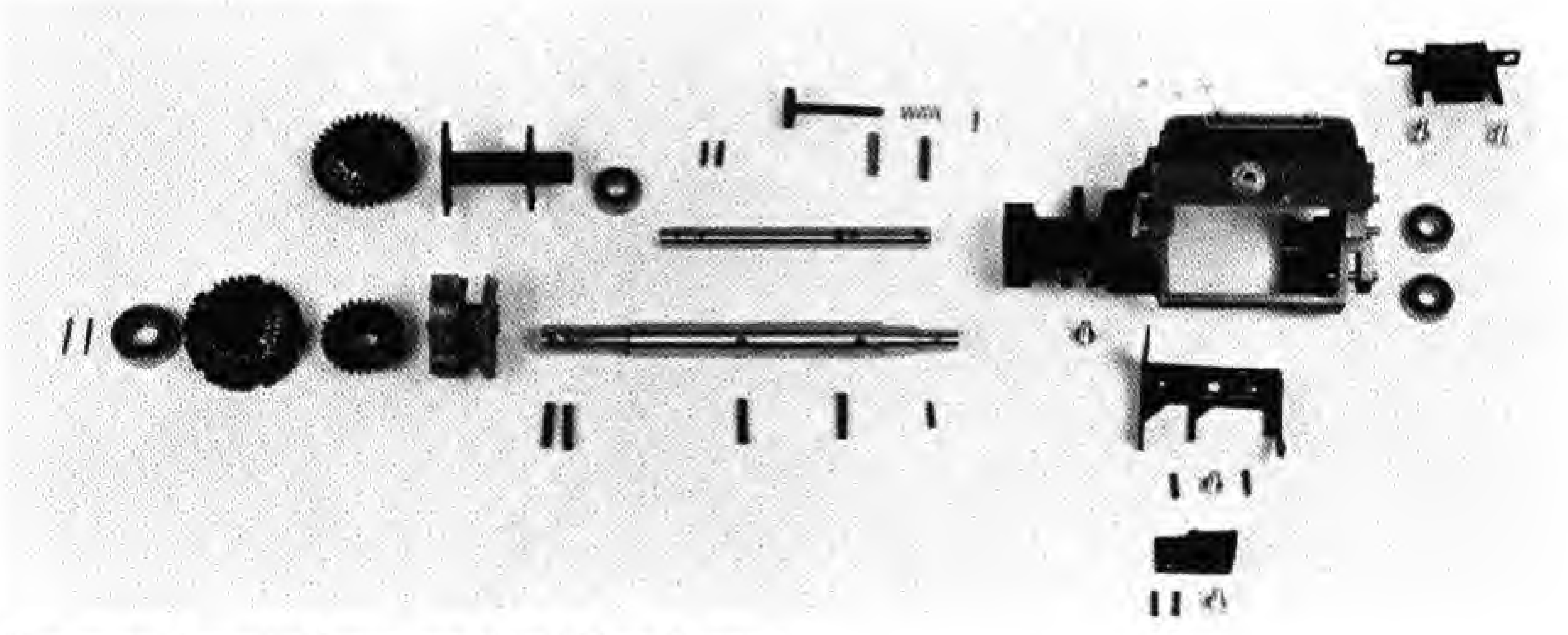
The 5.56mm Microgun is an anti-personnel weapon. It is designed for both aircraft and surface applications where the gun system weight and/or volume is critical or where an extended time on target requires higher ammunition capacity without the added weight penalty. It offers, in addition to the foregoing advantages, the selection of a low rate of fire ideally suited to surface applications, coupled with a reliability not found in any existing surface weapon. It is not intended to replace the 7.62mm Minigun, but to augment the 7.62mm's role by providing increased firepower combined with lightweight in selected situations and missions.

5.56mm Microgun Characteristics

Calibre	5.56mm (.233 cal.)
Muzzle Velocity	3250 ft./sec.
Weight:	
Basic Gun	25.5 lbs.
Drive Motor	7.5 lbs.
Feeder, Side-Stripping	3.0 lbs.
Length	27.0 inches
Firing Rate	Variable 400 to 10,000 SPM
Demonstrated Burst Length	Over 2500 rounds at 6000 SPM
Gun Drive	Electric
Power Requirement	0.75 HP @ 2000 SPM 1.5 HP @ 6000 SPM 3.2 HP @ 10,000 SPM
Recoil Forces:	
Average at 6000 SPM	100 lbs.
Safety:	
Gun	Manual Safety Provided
Ammunition Cook-off Hazard	automatic declutching clearing provided after each burst
Ammunition	M193 Ball M196 Tracer
Feed System	linked or linkless feed systems
Reliability	200,000 rounds/malfunction
Maintainability:	
Gun Life	500,000 rounds
Parts Replacement	50,000 rounds
Special Tools	None



5.56mm Microgun Bolt Assembly



Receiver and Assembly Components of the 5.56mm Microgun

The 5.56mm round weighs approximately one-half as much as the 7.62mm round. The gun system weight is much less than that of the 7.62mm Minigun system for the same ammunition capacity.

The 5.56mm Microgun is the smallest and lightest version of General Electric's externally powered six-barrel weapons which are known for their high reliability and rate of fire. Derived from the proven design principles of the M61, 20mm Vulcan Gun and the GAU-2BA 7.62mm Minigun, the 5.56mm Microgun specifically fulfills the need for a dependable lightweight small-calibre weapon for light aircraft, helicopters and surface applications. The Microgun fires the standard 5.56mm ammunition, which has been effective in combat in Southeast Asia.

Since the 5.56mm Microgun is driven by external power, dud rounds are cycled through the weapon at the normal firing rate. As a result, remote control of the 5.56mm Microgun is possible since it does not require a gun charger or charger system.

The rotor guides the six bolts and provides a well into which the bolts lock during firing. The bolt design, which is of reduced size and mass for long life and reliability is driven fore and aft by the main cam. The gun housing, a one-piece casting, includes the main cam, supporting lugs for the safing cover, internally mounted round guides, two bearings into which the rotor assembly mounts, as well as external attachments such as the support used to secure the motor drive.

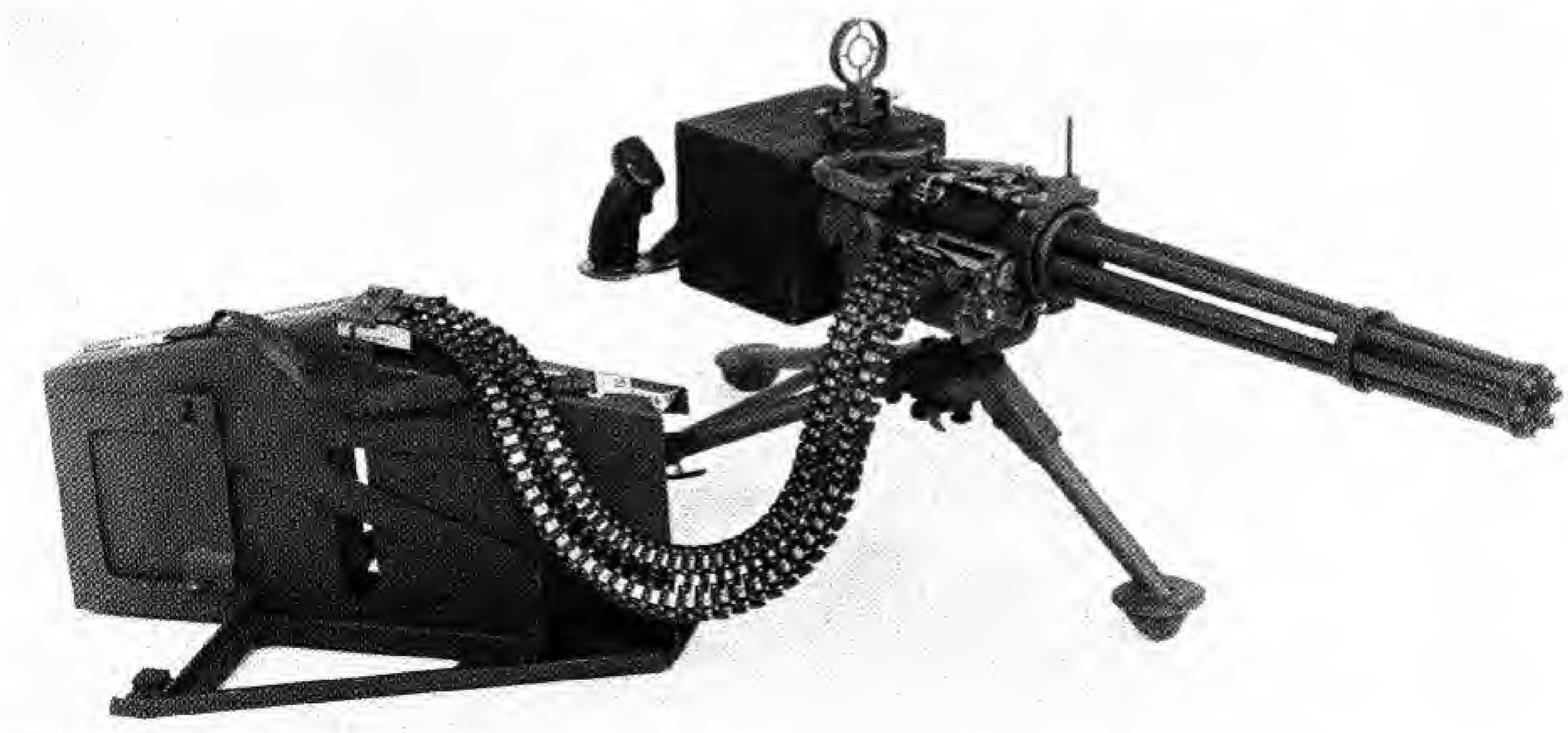
Six-Pak System Characteristics

System Weight (Loaded 1000 Rounds)	85 lbs.
System Safety	Master Arm Switch "Off" Safing Lever
Automatic Gun Clearing	
System Portability	Carried and set on vehicles or M122 Tripod
Gun	XM-214 5.56mm
Gun Weight	27 lbs.
Rate of Fire (Variable)	400-4000 spm bursts from 3 to 1500 Rounds
Barrel Life (Set)	100,000 Rounds
Recoil Force @ 4000 spm	100 lbs.
Gun Status	10 delivered to WECOM/USAF Successfully Passed 100,000 Round Test
Motor	24 VDC, 0.8 HP
Battery	24 VDC, Paste Electrolyte Cells
Battery Recharge	15 minutes pulse charging with temperature sensor
Electronics Package	Solid State Components Burst Length Control (Variable) Battery Condition Light

Detailed Cycle of Operation

The firing cycle begins when mechanical power is applied to the front gear of the rotor assembly via the electric motor.

The rotor assembly and barrels rotate counterclockwise, viewed from the rear with firing taking place from 10:00 to 11:00. As the rotor assembly turns, the roller on the outer surface of each bolt assembly follows the somewhat elliptical cam path formed on the inner surface of the stationary gun housing. Each bolt assembly, in turn, picks up a



5.56mm Six-Pak

cartridge from the guide fingers on the feed side of the guide bar as that bolt passes the feed section of the cam.

The continuing camming action upon the bolt assembly roller moves the bolt assembly and cartridge forward to ram and chamber the cartridge in the barrel about to fire. (At this time the previous barrel has fired and is about to unlock and extract.)

After the cartridge has been chambered, the bolt head is rotated by the interaction of the bolt head helical camming surface and the bolt subassembly as the cam continues to push on the roller. As the bolt head becomes fully locked in this position, the firing pin has been rotated off the cocking shoulder in the rotor to release the firing pin to fire the cartridge. The bolt assembly roller has then reached the forward dwell portion of the eliptical cam and is held there during firing where pressure builds, the projectile leaves the barrel and the pressure decreases.

At the end of the cam's forward dwell the bolt assembly roller enters the reverse segment of the cam path. The bolt head unlocks by reverse cam action with the body bolt. Further travel of the bolt assembly roller along the cam's reverse segment moves the bolt assembly to the rear and extracts the spent cartridge case from the barrel chamber.

An extractor lip on the face of the bolt head holds the spent case until it is cammed out by the ejection side of the guide bar and ejected. The bolt assembly continues to follow the rear dwell of the cam path into a position to receive another new cartridge from the feeder. At this point the bolt assembly has completely cycled through the gun and the elliptical cam path. All six bolt assemblies continually repeat this cycle one at a time while power is applied to the front gear of the rotor assembly.

While one bolt assembly is at the feed position the bolt head is about to lock and fire. The next bolt head has fired and is about to unlock. The third bolt head is extracting a fired case. The fourth bolt head is advancing in extractors and getting ready to eject. The fifth bolt head has ejected and is in rear dwell.

The six bolts, as are the barrels, are spaced 60° apart from each other, and each is performing one of the gun cycle functions of feed, ram, lock, fire, extract, and eject. Of course, as another 60° rotation of the rotor barrels and bolts occurs each bolt advances to the next gun cycle function directly ahead of it and so on as the gun rotates and fires.

5.56mm Microgun Pod Description

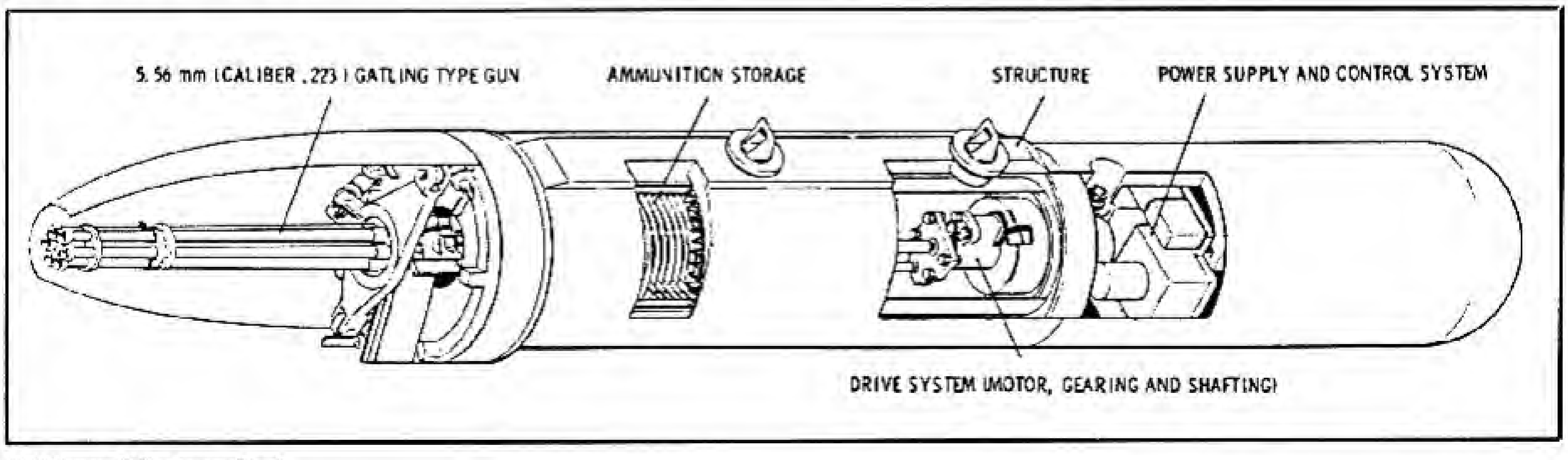
The 5.56mm Microgun pod is an externally-stored gun pod for use on light aircraft and helicopters where accurate, concentrated firepower with minimum weight is required.

The pod can be provided with an ammunition capacity from 1500 to 3500 rounds with an approximate loaded weight from 186 to 300 pounds, respectively. The nominal rate of fire is 6000 spm; however, multiple firing rates (such as 1000, 6000 and 10,000 spm) are available.

The pod utilizes the 5.56mm Microgun and a linkless feed system, both of which are derived from proven design principles. Equivalent components in the 7.62mm size have fired over 30 million rounds.

The gun and linkless feed system are externally powered for maximum reliability. This external power is provided by a battery pack, located within the pod. Only control voltage and a battery trickle recharge voltage are required from the aircraft. If desired, the pod may also be fired using aircraft power.

The pod is mounted by two suspension lugs which are movable to provide three degrees of azimuth and elevation boresight adjustment.


5.56 mm (CALIBER .223) GATLING TYPE GUN
AMMUNITION STORAGE
STRUCTURE
POWER SUPPLY AND CONTROL SYSTEM
DRIVE SYSTEM (MOTOR, GEARING AND SHAFTING)

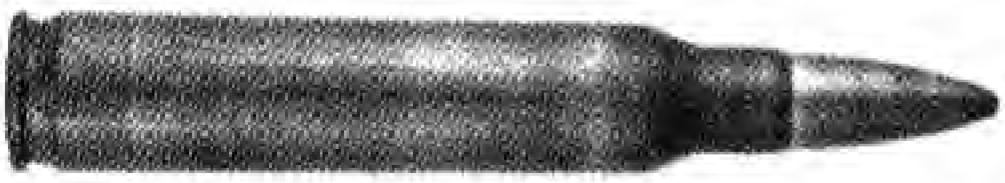
5.56mm Minigun Pod

Reloading is accomplished, without the aid of special ground support equipment, by a built-in power reloading system or by an auxiliary hand crank.

The major sections forming the 5.56mm Microgun Pod are the forward section with gun and fairing, the center section with drum assembly, and the aft section with battery, controls, and fairing. The center section (ammo storage) can be provided in any capacity from 1500 to 3500 rounds. These different capacity center sections are interchangeable to provide whatever ammunition capacity the mission may dictate.

Ammunition

The ammunition used in the 5.56mm Microgun is the same as that used in the M16 rifle. It is the standard round used by the ground forces. Links have been manufactured for the 5.56mm ammunition and have shown a higher strength to weight ratio than their 7.62mm counterparts. In tests with the 5.56mm Microgun, the links have functioned reliably at rates of fire up to 10,000 spm.



Six-Pak G.E. (XM214) Ammunition. (Photo courtesy of Woodin Laboratories.)

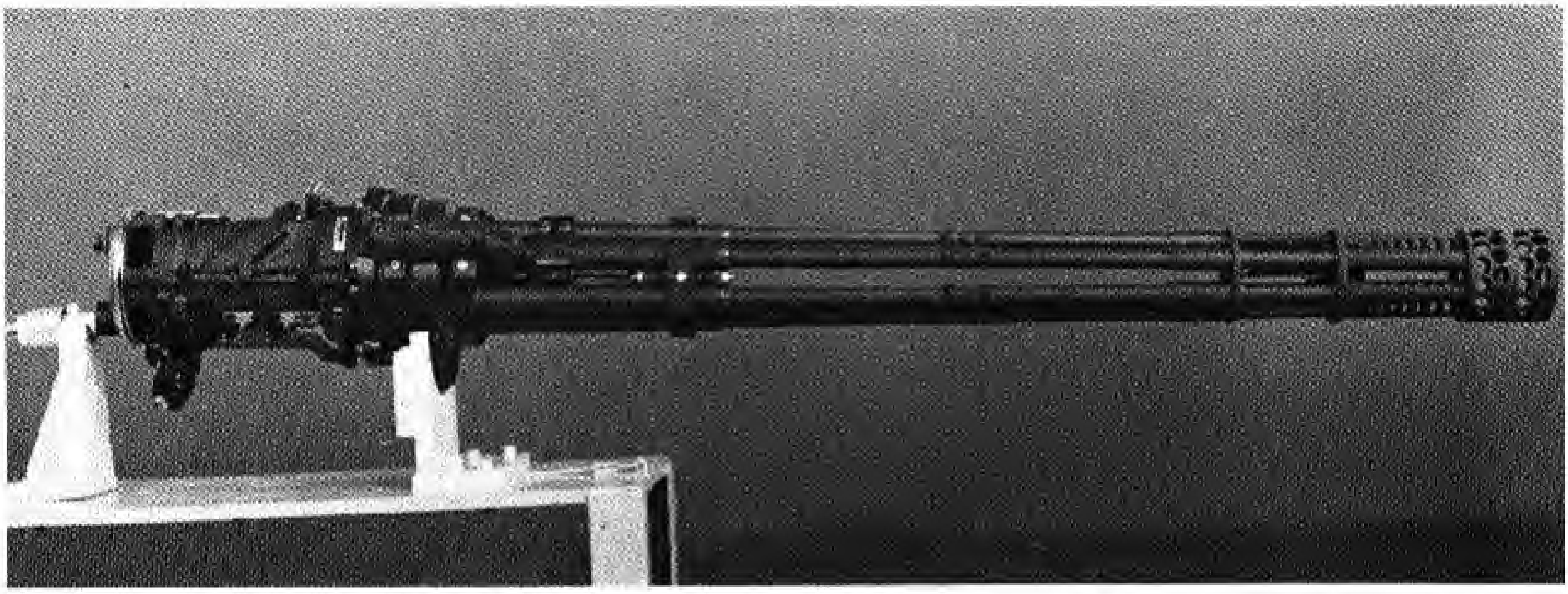
5.56mm Microgun Pod Characteristics

Calibre	5.56mm (.233 cal.)
Muzzle Velocity	3250 ft./sec.
Ammunition Capacity	1500-3500 Rounds (As Required)
Weight:	
Loaded (1500 Rounds)	186 lbs.
Empty	149 lbs.
Loaded (3500 Rounds)	300 lbs.
Empty	214 lbs.
Loading	Self-contained power loading and/or auxiliary hand crank
Rate of Fire	Fixed rates available from 400 to 10,000 SPM
Case Ejection	Bottom of pod
Boresight Adjustment:	
Elevation	±1½°
Azimuth	±1½°
Dispersion	6 mils 80% circle-hard mount
Mounting	14 inch lug spacing
Control Power Requirements	28V d-c. 15 amps
Length (1500 round Capacity)	60 inches
(3500 round Capacity)	88 inches
Diameter (1500-3500 round Capacity)	10 inches
Safety:	
Gun	Manual safety provided
Cook-off Hazard	None (automatic declutching clearing provided at the end of each burst)
Ammunition	Ball and Tracer
Reliability	55,000 Rounds Malfunction
Maintainability:	
Pod Life	500,000 Rounds (Minimum)
Parts Replacement	50,000 Rounds (Minimum)
Special Tools	None Required
Loading (1500 Rounds):	
Manual	6 minutes
Power	3 minutes

Chapter 6

20mm GAU-4/A XM130 GAS DRIVEN VULCAN

GENERAL ELECTRIC



20mm GAU-4/A XM130 Gas Driven Vulcan

History

The development of the GAU-4/A was done by General Electric. However, earlier work was done by Armour Research Foundation between 1956 and 1959.

The production drawings were issued October 29, 1965 and the first production contract was issued in 1966 and by November 1972, 1102 had been built.

The objectives of this program were to design and develop a gas-operated system for the 20mm gun, M61 (formerly T171E3), and the accessories necessary for successful operation of that system.

The drive system, the design of which was based on a similar system developed at ARF for the Rocket Launcher, T132, consists essentially of a set of six pistons, each of which is in a fixed relation to a barrel and is connected to that barrel by a common orifice plate containing gas passages. Associated with each piston is a cylinder which is set in a fixed radial and sliding longitudinal relation to the barrel cluster. Each cylinder carries a cam follower, which operates on a drive cam that is fixed to the stationary gun housing. The entire system - barrel cluster, orifice plate, pistons, and cylinders with cam followers - rotates with the gun rotor with respect to the gun housing and mounts. When the gun is fired, the projectile passes the orifice in a barrel allowing propellant gases to enter the corresponding cylinder. As the cylinder moves away from the piston, the cam follower acts on the drive cam to rotate the assembly. The repetition of this cycle as the barrels are fired in sequence effects driving of the gun at a firing rate of 6000 spm.

A starting system was designed to initiate firing of the gun after an interruption. For instance, if the gun were to stop between firing stations, the starting system would rotate the gun until a live round reached battery and was fired. The starter consists of a pneumatic cylinder and piston, a helical cam and nut, and an overrunning clutch, the entire assembly is mounted concentric with and is contained inside of the rotating system of the gun. In operation, compressed air is admitted into the cylinder and the piston pushes the helical cam through the helix nut, which rotates the gun through the overrunning clutch; the clutch allows the gun to overrun the starter during firing. The starter will accelerate the gun through 240° of rotation to a firing rate of approximately 1350 rd/min. in about 310 msec.

A pneumatically actuated multiple-disc brake using commercial discs was designed to brake the gun at the end of a burst and thus prevent excessive "overrun" (a larger number of live rounds cycled through the gun unfired). This brake will stop the gun in less than 270° of rotation.

A pneumatic system was designed to store sufficient air at high pressure for one complete aircraft mission and to supply the starter and brake systems with air at the proper pressure (500 psi for the starter and 150 psi for the starter piston return and for the brake).

A control circuit was designed to sequence the pneumatic valves which control the starter and brake and to coordinate the firing voltage with the valve sequencing.

Two complete powder-gas-operated drive systems were fabricated, and two T171E3 guns were modified to incorporate the drive and accessories. One gas-drive gun was subjected to a life test of 10,000 rounds fired in a 50-rd bursts. No appreciable wear was apparent.

It should be remembered that Gatling himself did some work on a gas driven Gatling in the 1890s.

Description and Purpose

The GAU-4/A is a gas-operated version of the proven M61A1 Vulcan gun. It was designed to provide a gun with the firing capabilities of the M61A1 for installations lacking power to drive a gun. This gun is self-powered by gun gas which is bled from four of the six barrels. The firing rate is approximately 6,000 shots-per-minute.

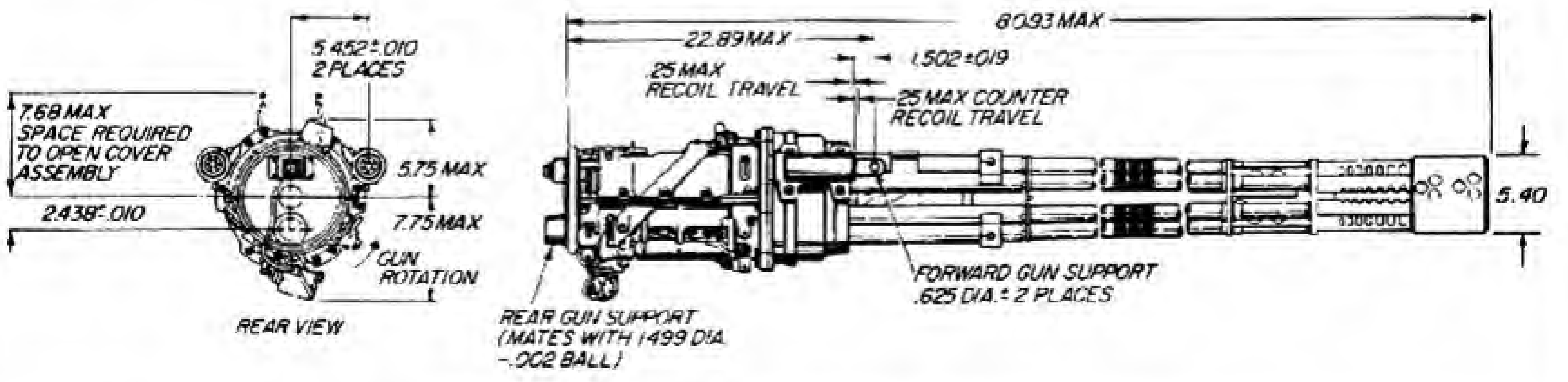
Characteristics

Gun (with Blast Diffuser):	
Length	80.93 in.
Width	13.2 in.
Height	13.5 in.
Weight	276 lbs.
Number of barrels	6
Gun Life	150,000 rds.
Barrel:	
Length	60 in.
Weight	18 lbs.
Barrel Life	20,000 rds. (minimum)
Performance:	
Rate of Fire	4000-6000 spm
Muzzle Velocity	3380 ft./sec.
Average recoil force	
at 4000 spm	2,661 lbs.
at 6000 spm	3,818 lbs.
Reliability	100,000 MRBF

The weapon will continue to fire even in the event of three consecutive misfires. The GAU-4/A fires standard, electrically primed 20mm M50 series ammunition.

The GAU-4/A is mounted in the USAF SUU-23/A Gun Pod (USA-XM-25).

The SUU-23/A carries 1200 rounds of 20mm ammunition in a linkless ammunition feed system. The linkless feed system provides positive control of



20mm GAU-4/A XM130 Gas Driven Vulcan

ammunition throughout all storage and feed operations.

The SUU-23/A gun pod attaches to standard 30 inch, double lug, suspension racks, but with minor modifications it can be made compatible with other type racks.

Cycle of Operation

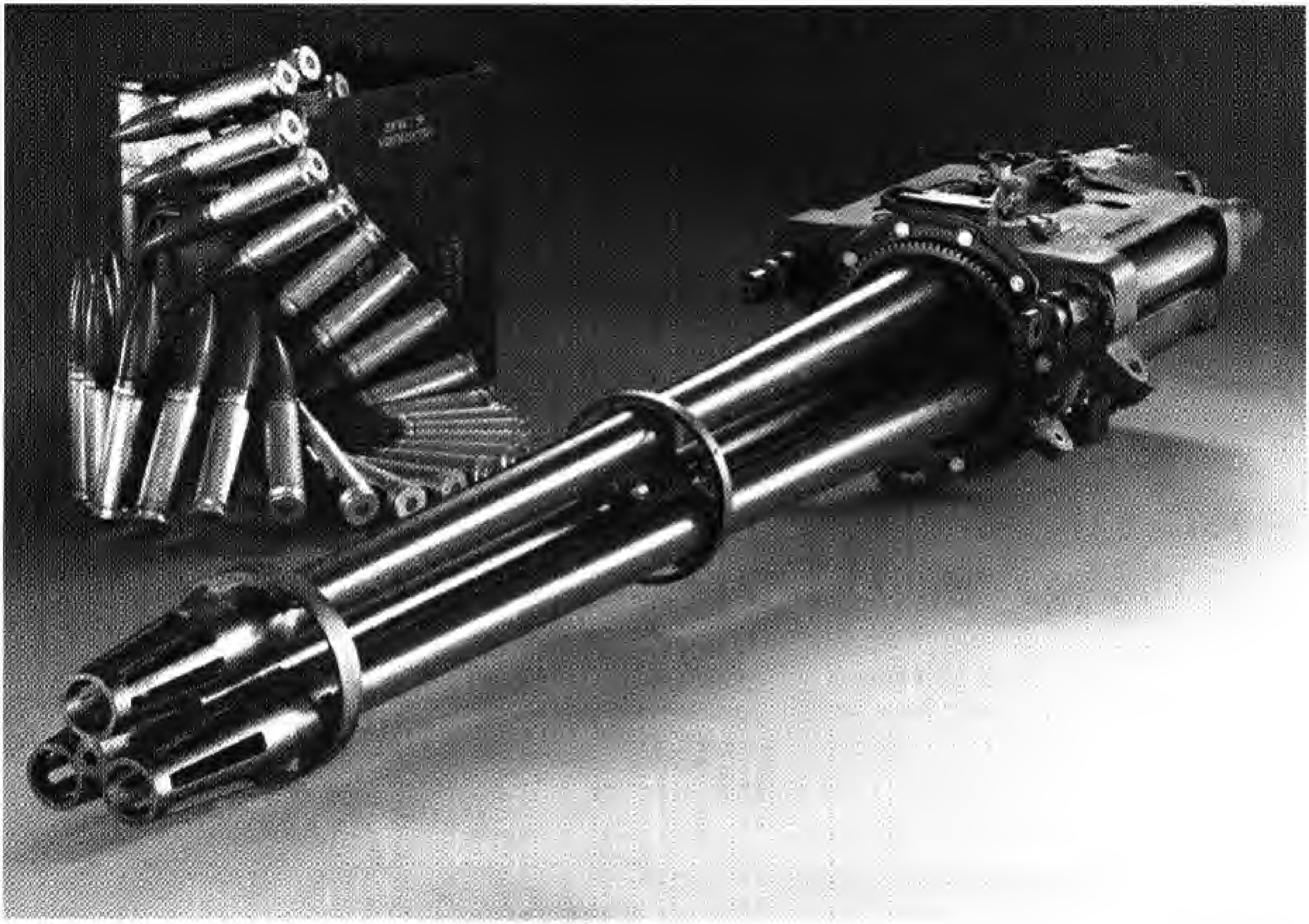
The cycle of operation differs from the standard Vulcan guns in that gas is tapped to drive the gun.

The cam action in chambering, firing, and extracting rounds in the six rotating barrels is identical to the M61. However, a gas piston and drive cam assembly is mounted in the center of the barrel cluster in place of the externally powered drive. The gas cylinder is rigidly connected to the gun barrels and rotates with the cluster. The piston is double acting. It reciprocates on a ball spline which is anchored to the rear plate of the stationary gun housing. The cam on the piston shaft drives the barrel cluster as the piston reciprocates under the double acting gas pressure. A cam follower mounted on the barrel cluster drives the cluster in a rotary motion. Gas is tapped from four of the six barrels. Initial barrel rotation is provided by an electrically driven inertia starter. After accelerating the weapon to an approximate rate of 5400 shots per minute (in about two-tenths of a second), the starter disengages itself automatically, and the weapon drives itself up to the 6,000 shot-per-minute firing rate. A governor holds the weapon's firing rate at a constant 6,000 shots per minute.

Chapter 7

30mm XM188 AUTOMATIC GUN

GENERAL ELECTRIC



30mm Machine Cannon XM188 General Electric (3 Barrel Gatling)

History

The Armament Department of the General Electric Company conducted a 30mm gun concept study in March 1966 and began detail design in May 1966. Four development GE 3-barrel, 30mm XM188 guns were designed and built under the Independent Research and Development Program. The 30mm T212 and 20mm M61 can be regarded as this weapon's antecedents.

The GE 3-barrel, 30mm weapon was first proposed to the army August 1, 1966 with an unsolicited proposal to the Army weapons command. In response to the unsolicited proposal, the Army made available 3500 rounds of ammunition used to conduct firing tests. General Electric fired over 3000 rounds on the four guns and sufficient data was accumulated to assure that the weapon would be more reliable than the well proven M61. The XM188 guns have been fired at rates of from 300 spm to nearly 2000 spm. The limited amount of ammunition fired was due to a lack of ammunition not to gun problems. All design goals were reached.

Description and Purpose

The design of the 30mm XM188 weapon was undertaken to meet the need for a large-calibre, air-to-ground, close-support weapon for use on armed helicopters. The gun was designed to fire at intermediate rates. Nominal firing rate was 2000 rounds per minute and the gun was also capable of firing at lower rates. Selection of 2000 rpm was based upon the tactical requirements of helicopters and fixed-wing aircraft in attacking ground targets. Power for driving the gun can be supplied from external sources through AC or DC electric drives or a hydraulic motor.

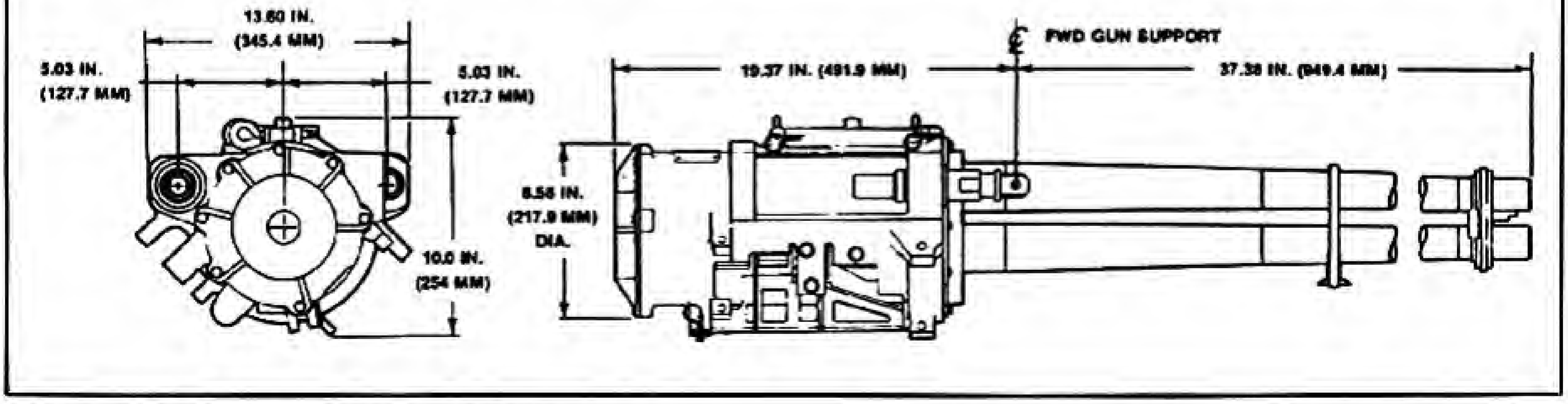
The XM188 was a candidate for Bell Helicopters YAH-63. The XM188's significant performance advantages, coupled with incorporated weight reductions, provided the YAH-63 with greater survivability.

Cycle of Operation

The cycle of operation is identical to the standard M61A1 Vulcan. Each of the gun's three barrels fires only once during each revolution of the barrel cluster. Barrels are attached to the gun rotor by interrupted threads. No head space adjustment is required. The gun rotor is journalled within a stationary outer housing and contains the three gun bolts. The bolts slide fore and aft on tracks and provide the ram, lock, fire, unlock, and extracting functions. The stationary outer housing includes a main cam which drives the bolts through their respective functions. The three rotating barrels contribute to a long weapon life by minimizing barrel erosion and heat generation. This method of operation also eliminates erratic recoil associated with multiple gun installations.

Characteristics

Bore Size	30mm
Muzzle Velocity	2200 fps
Rate of Fire	2000 rpm
Basic System of Operation	Power Driven (electric)
Locking System	Locking Block
Power Source Feed System	Power Driven
Feed System	Sprocket Type
Type of Feed (Location)	Link
Method of Chambering	Ram
Type of Accelerator	None
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	U.S. Army
Manufacturer	General Electric
Developer	General Electric
Ammunition Type	XM552
Gun Size:	
Length	58 in.
Width	14 in.
Height	15 in.
Weight	150 lb.
Barrel Length	42 in.
Type of Firing Mechanism	Percussion
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Electro-Mechanical
Lineage	Gatling



Outline of 30mm Machine Cannon XM188

The major difference in the operation of the XM188 and that of the M61A1 is the ammunition. The M61A1 fires electrically primed ammunition through a firing pin located in each of its six bolts. The XM188 fires percussion primed ammunition with a single firing pin spring, mounted on a housing cover. This pin supplies energy to each of the three gun bolts and provides a positive safing feature. The manually operated housing cover can be opened thereby separating the spring from the firing pins. The gun also incorporates a declutching feeder which clears rounds from the gun at the end of each burst.

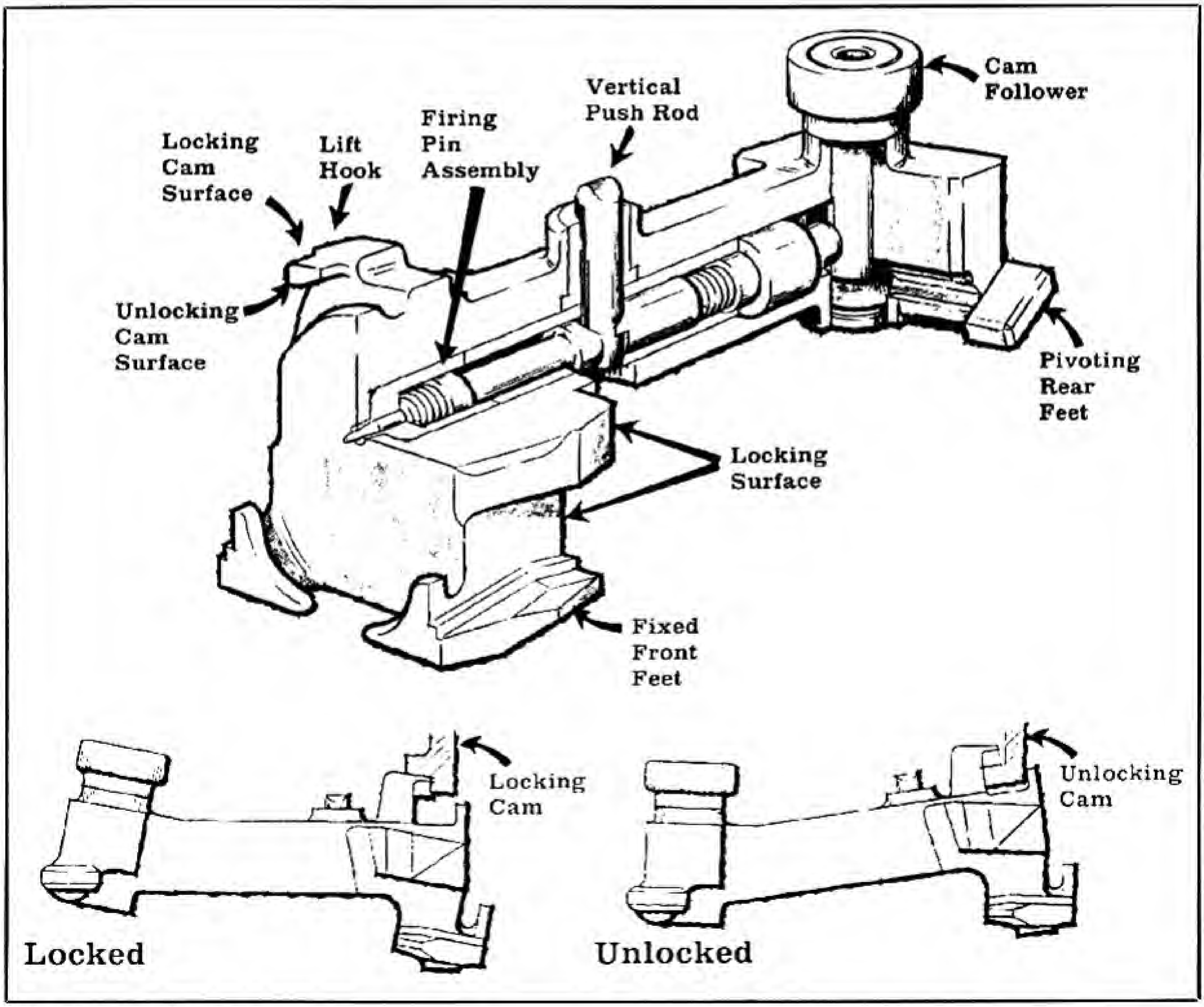
The gun is designed to be interchangeable with the M197 gun. In turret installations, for example, the gun could be completely interchanged with the M197 with no aircraft modifications. This flexibility offers an aircraft firepower tailored to its mission needs.

Bolt Design

The XM-188E1 bolt is a drop-head type. The bolt body is machined from a high strength 17-4 investment casting and is case hardened.

The bolt is guided in the rotor tracks by two fixed front feet which are an integral part of the bolt body, and by two pivoting rear feet, of electroless nickel plated maraging steel, separately installed at the rear. Side guide surfaces, which contact mating surfaces in the rotor, are machined into the bolt body.

The bolt cam follower is a 1 inch (2.5 cm) diameter


Cam Follower
Vertical Push Rod
Firing Pin Assembly
Locking Cam Surface
Lift Hook
Unlocking Cam Surface
Pivoting Rear Feet
Locking Surface
Fixed Front Feet
Locking Cam
Unlocking Cam
Locked
Unlocked

XM188E1 Drop Head Bolt

spherical steel roller located in the top rear of the bolt. The steel roller rotates on a stud mounted into the bolt body; and is interlocked by the rear feet. The total travel of the bolt cam follower along the pitch diameter of the cam is 28 inches (71 cm) per rotation, during which time the bolt travels only 7.8 inches (19.8 cm) forward and aft. Since this total axial travel is short compared to the total path length, the cam slopes and acceleration/deceleration corners are very gentle.

During firing, rounds are positioned directly in front of the bolt ramming face while the bolt is rotating through rear dwell, and are held securely in place by the bolt extractor fingers. Rotation of the rotor causes the bolt and round to accelerate forward, chamber the round, and decelerate to a stop at forward dwell. After the round is fully chambered, the bolt head contacts a closing cam which pivots the head of the bolt radially inward so that the locking lugs are aligned with the mating locking lugs in the rotor. At the full lock, the spring-returned firing pin plunger assembly, located inside the bolt body, aligns with the centerline of the bolt/cartridge. After the bolt reaches the fully locked position, the vertical push rod (see bolt illustration) contacts the cover-mounted ignition cam. Actuation of the push rod causes the firing pin plunger to be cammed forward and extend out of the bolt face, completing the electrical ignition continuity to the cartridge primer.

After appropriate dwell time at full lock (to allow pressure decay), the bolt head is lifted out of the rotor pocket by a lift cam fastened to the gun housing which acts on the lift hook of the bolt. As the bolt head is lifted from the locked position, the extraction groove is again aligned with the cartridge. Continued rotor action draws the empty case from the barrel.

Test Results

The XM188's reliability was forecasted based upon operation and maintenance requirements similar to the 20mm M61 gun. Using this as a basis, the reliability of the 30mm gun was forecasted as follows:

At Time of ET/ST	10,000 MRBS
At Unit No. 1000	30,000 MRBS

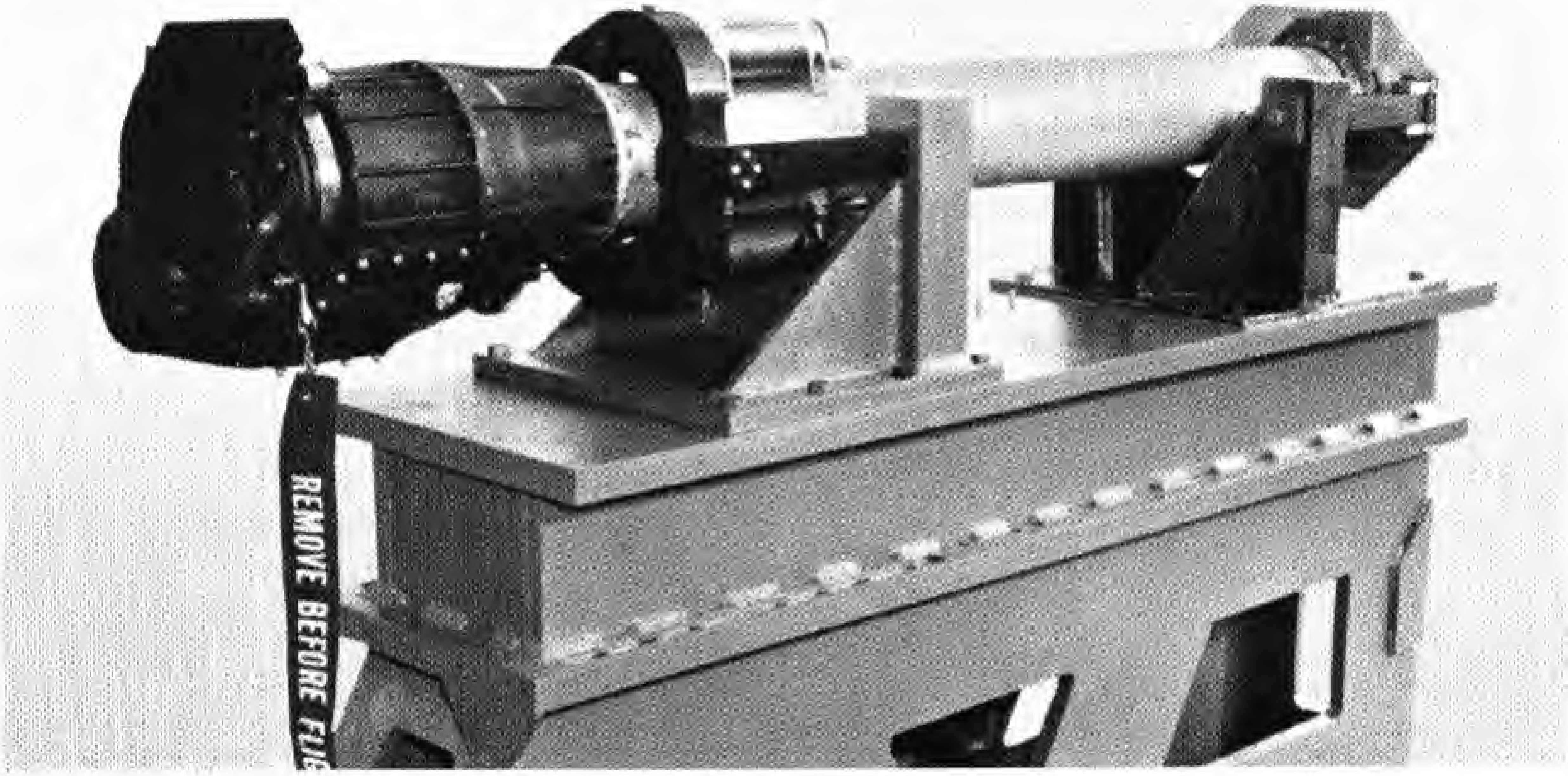
The rotational speed for the 30mm gun is lower as a result of the lower ratio of fire. Since wear is proportional to speed, less wear should be experienced for equivalent number of rounds fired with the 30mm gun. There are less functional components in the 30mm than in the 20mm gun so that the chances for parts failures will be reduced.

There are many design features in the 30mm which are improvements over the 20mm gun and which should provide longer life (e.g., a less complex bolt lock design and the elimination of vertical reaction loading on the rotor trackway).

Chapter 8

25mm GAU-7/A CASELESS AUTOMATIC MACHINE GUN

PHILCO-FORD CORPORATION



25mm GAU-7/A Machine Gun

History

In January 1968, a program (Phase I) was initiated to conduct advanced design and development of a 25mm high rate-of-fire gun capable of firing fully telescoped, caseless ammunition. The program was initiated by the Air Force to fulfill a requirement for a high-performance, air-to-air gun system for the F-15 advanced fighter aircraft. The primary objectives were to: design a weapon for fully telescoped, caseless ammunition; design and develop fully telescoped caseless ammunition; design a linkless feed system; design and fabricate a single shot test fixture; fabricate one-half scale working model; and prove concept feasibility with 100 round test.

These objectives were met by Philco-Ford. The Phase II program was conducted from March 1969 through April 1970, to design and fabricate a rapid-fire gun and an associated test feed mechanism, and to continue development of compatible, fully telescoped, caseless ammunition. The primary objective of this program was to prove feasibility of the gun system. The program met or exceeded gun performance objectives. The gun was capable of firing 25 round bursts at 6,000 rpm, which was never demonstrated because the feed system could not achieve full-rate operation.

In May 1970, Phase III was started for further development of the advanced design of a lightweight, 25mm, rapid-fire aircraft gun, the test feed system for the gun, and the compatible caseless ammunition. This program included fabrication, test, and delivery of two complete gun systems and 10,000 rounds of ammunition for evaluation tests at Eglin Air Force Base, Florida. These tests were successfully completed in November 1971, and all major program objectives were met.

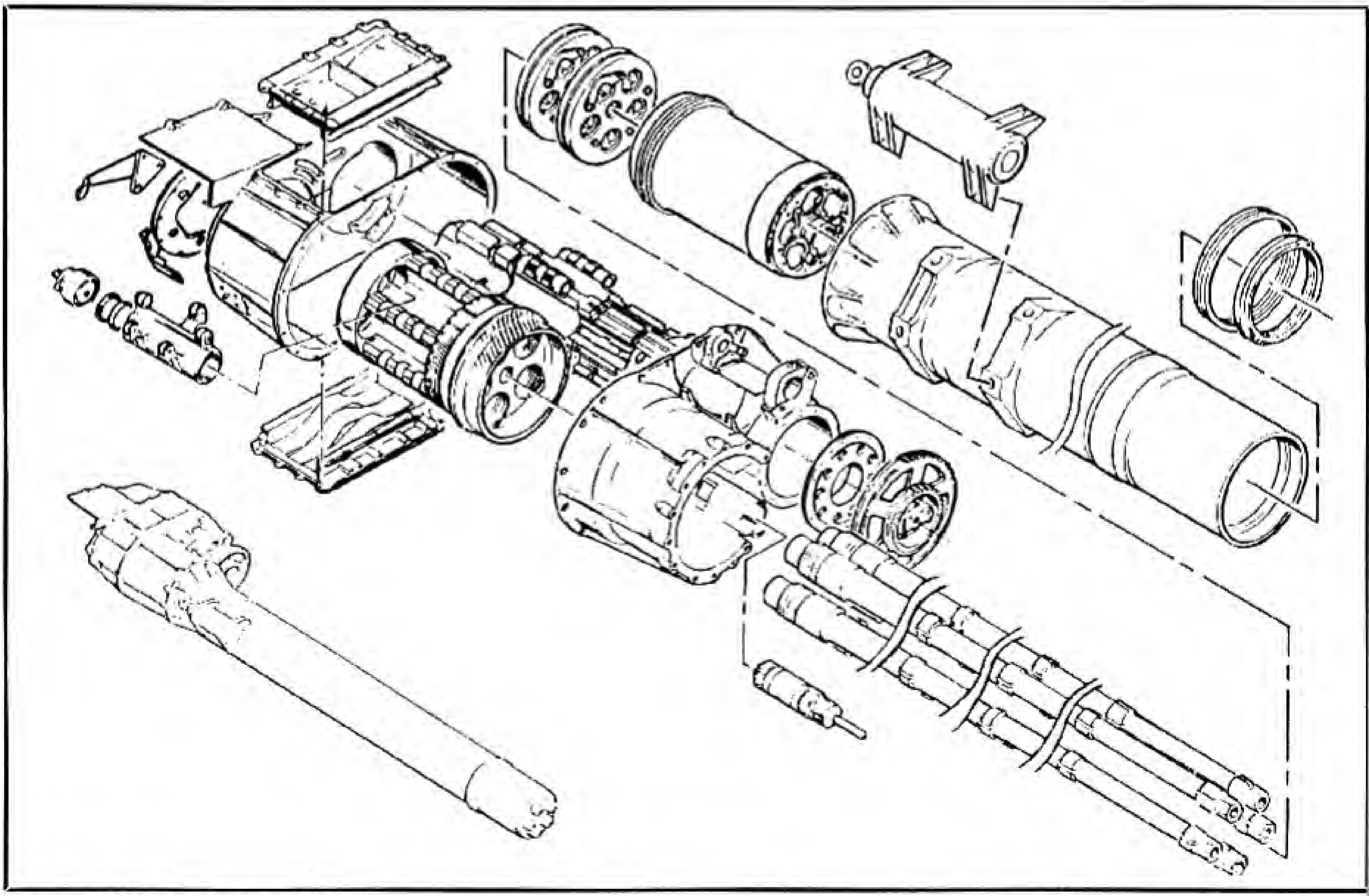
The work on the Phase III GAU-7 culminated with the Eglin Air Force Base tests from July to December of 1971.

Work on the Philco-Ford Phase IV GAU-7 gun proceeded until the contract was cancelled in 1974. The contract was cancelled due to problems associated with changes in safety requirements.

Subcontractors who worked on the ammunition included Brunswick, Aerojet, Hercules and Honeywell through Phase III and Brunswick, AVCO (Richmond) and AVCO (Lowell) in Phase IV. A total of 10 guns were included in Phase IV.

Characteristics

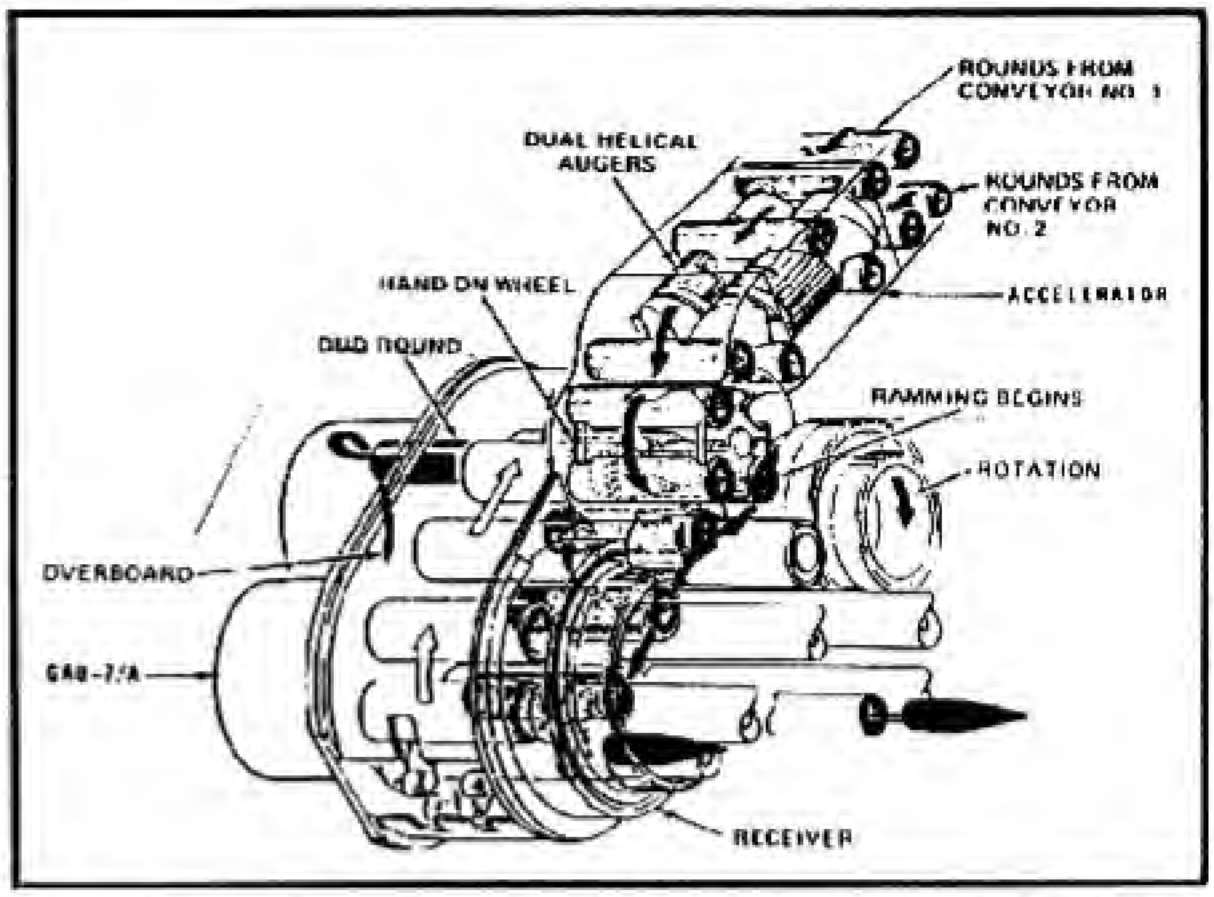
Bore Size	25mm
Muzzle Velocity	Classified
Rate of Fire	6,000 rpm
System of Operation	Power driven
Method of Headspace	Fixed
Selective Feed	No
Type of Feed	Rotary, Conveyor
Method of Charging	Hydraulic, 3,000 psi
Users	USAF
Manufacturing Rights	USA
Ammunition:	
Type	Caseless
Rights	USA
Gun Length	90 in.
Gun Weight	426.23 lbs.
Barrel:	
Length	84 in.
Weight	182.68 lbs.
Removal	Rapid
Number	5



25mm GAU-7/A (Exploded View)

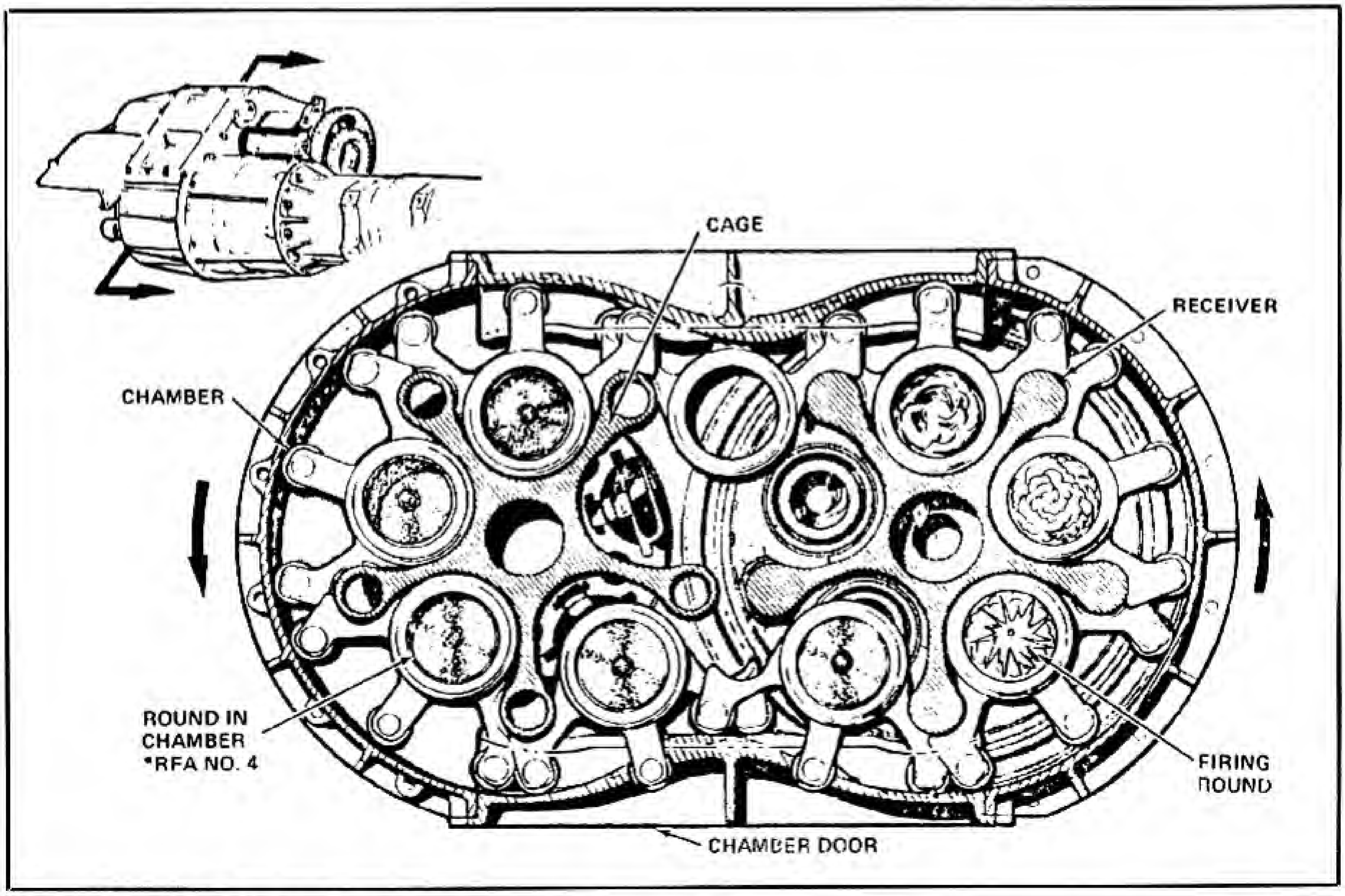
Description and Purpose

The Philco-Ford GAU-7/A Phase III 25mm gun employs five rotating barrels and fires fully-telescoped caseless ammunition at selectable firing rates of 3,000 and 6,000 rpm. The gun incorporates an ammunition-rammer sprocket and a receiver sprocket located side by side and contained within a main bearing and chamber housing. Nine linkless chambers rotate about and are passed between the receiver and rammer sprockets. Chamber retention, transport, and positioning are provided by a system of rollers and cam paths. The chambers receive incoming rounds while in synchronization with the rammer sprocket. The chambers are transported to the receiver where the round is fired in synchronization with the receiver. The rammer and receiver systems rotate at 1,200 rpm (full rate fire) with the chambers traveling at a tangential velocity of approximately 23 fps.

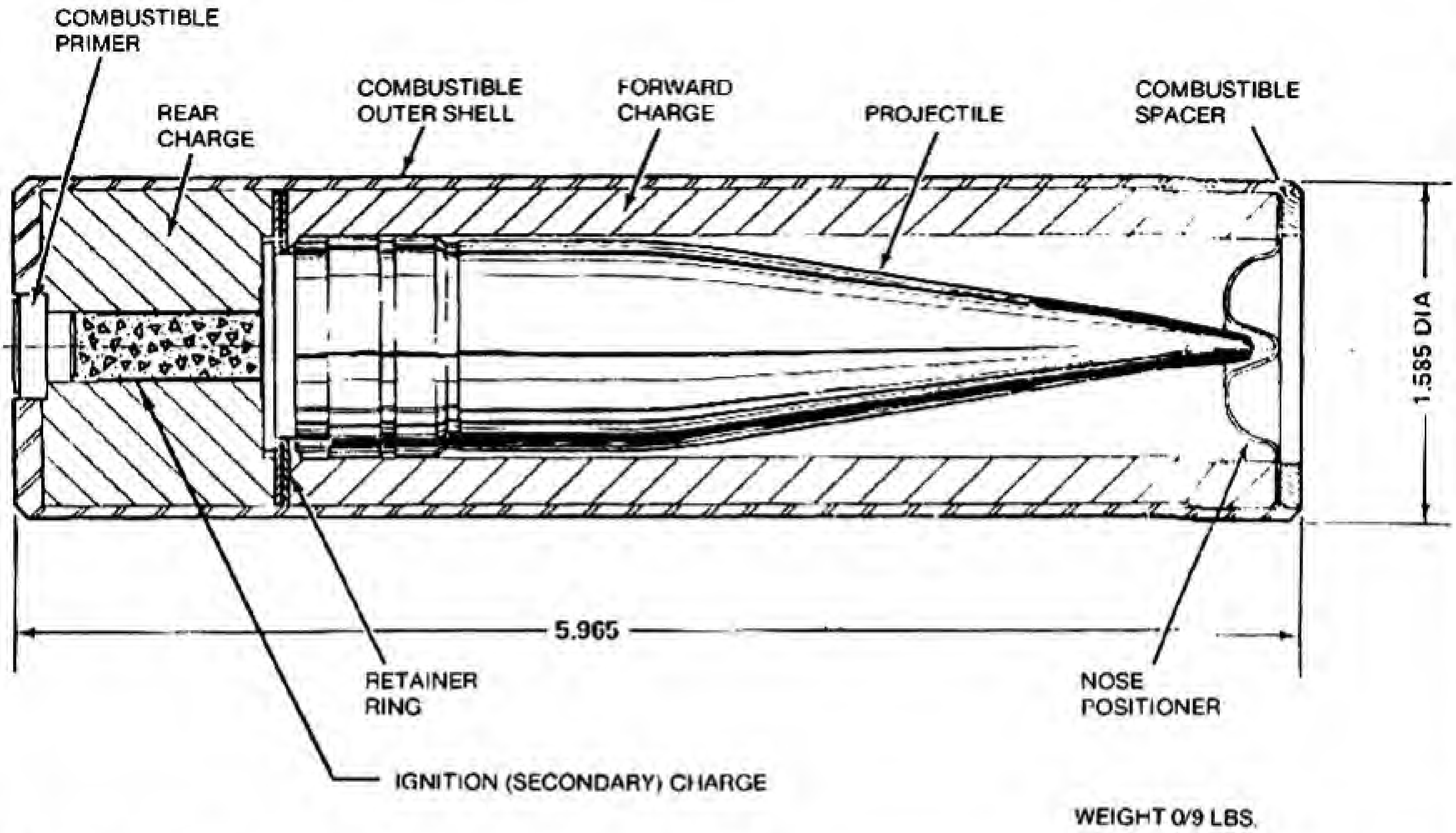

ROUNDS FROM CONVEYOR NO. 1
DUAL HELICAL AUGERS
ROUNDS FROM CONVEYOR NO. 2
HAND ON WHEEL
ACCELERATOR
DUD ROUND
RAMMING BEGINS
ROTATION
OVERBOARD
GAU-7/A
RECEIVER

Rounds traveling through the Accelerator and their Path inside the Gun

The receiver is a five-pocket sprocket which retains the barrels, firing pin assemblies, chamber seals, and the main support bearing. As the chambers move into battery, they are accurately positioned and are locked into position by a center cam track. Seals are housed in cavities provided in the receiver at both the forward and aft ends of the chamber. At


CAGE
RECEIVER
CHAMBER
ROUND IN
CHAMBER
*RFA NO. 4
FIRING
ROUND
CHAMBER DOOR

Cross Section of the Receiver Housing



Cut-A-Way of Brunswick 25mm Telescoped Round showing Major Components.

ignition, the seals are pressure actuated to provide a seal between the chamber and the barrel and between the chamber and the breech. The chambers are basically cylinders with cam rollers on lug extensions which control the chambers during transport in the gun. The chambers remain under positive control at all times in translation from rammer sprocket to the receiver cam rollers. The rammer cage and receiver, driven by a common drive, provide the power for translation of the chambers.

The gun is 90 inches long, the chamber housing is 19 inches in diameter (maximum), and is powered by an external hydraulic drive motor of 60 horsepower. The total gun weight was 426 pounds.

Cycle of Operation

At 6,000 rpm, each round enters the gun from the feeder via the hand-on wheel at a speed of 23.6 fps. The rammer, which has been withdrawn to its rear position by the rammer cam track, rams the round into a chamber. The ramming operation is completed in approximately 25 milliseconds. At this point, the chamber is handed off from the cage sprocket area to the receiver sprocket.

The chamber and round are transported from the rammer cage to the receiver by the combined action of chamber rollers and cam paths in the chamber housing.

When the chamber reaches the battery position (approximately 6:30 o'clock position looking from the rear of the gun) the firing pin is dropped.

The firing pins (one per barrel) are cocked by the wobble plate, which compresses the firing pin spring, causing the pin to engage the firing pin sear.

The cam path in the nonrotating centerpiece releases the cam drive sears at the proper instant. External secondary sears are also used to provide an additional safety. These are mechanically controlled by a lever. This lever is positioned by a flagged pin.

In the event of a dud round, the next incoming round which is rammed into that chamber will force the round out of the chamber and into the dud extractor bars. The round is then rotated until it reaches the dud eject chute where the centrifugal motion forces the round up and out of the gun. There are no provisions for dud ejection during the last nine rounds in a burst.

Test Results

The U.S.A.F. comparative test of the Phase III GAU-7 guns was published in May 1972 and based on the results of that test the Philco-Ford GAU-7 was selected for further development and the General Electric GAU-7 development ceased.

In general, the performance of the Philco-Ford GAU-7/A, while hard-mounted, could be considered excellent. A high degree of confidence was experienced in the gun's ability to successfully accomplish any firing up to and including 150 rounds at 6,000 rpm. Out of a total of 87 burst firings (54 bursts of 40 rounds or more), only one stoppage could be considered a major gun malfunction, the failure of the receiver centerpiece locking bar. Of the remaining three stoppages, two were the result of deficiencies of the Philco-Ford hydraulic power supply and one was caused by a jam in the test feed system.

Philco-Ford's GAU-7/A candidate demonstrated the potential of caseless ammunition when fired at high rates of fire for an aircraft gun system; however, further development is needed before the system could be considered for production. The greatest technical problem in the program was reproducibility and quality control of the telescoped caseless ammunition on the interior ballistic cycle.

Summary of Findings

The Philco-Ford GAU-7/A gun successfully fired at both 3,000 and 6,000 spm. The Philco-Ford GAU-7/A repeatedly fired bursts of 150 rounds or more at both high and low rates of fire.

The acceleration time of the GAU-7/A to reach 90 percent of the 3,000 spm firing rate ranged from 192 msec to 421 msec. Deceleration after firing until the end of gun rotation varied from 284 msec to 833 msec.

The acceleration time of the GAU-7/A to reach 90 percent of the 6,000 spm firing rate varied from 151 msec to 668 msec. Deceleration after firing until the end of gun rotation varied from 240 msec to 746 msec.

The Philco-Ford GAU-7/A demonstrated that it could eject misfired rounds at high and low rates of fire.

Impact dispersion for 100-round bursts at 3,000 and 6,000 spm varied from 3.46 to 4.60 mils and from 5.40 to 8.28 mils respectively for 80 percent of the rounds in each burst.

Ammunition velocity at ambient conditions varied between 122 and 428 fps below design velocity.

Ammunition residue after firing was a contributing factor to chamber and seal face gas cuts.

The Philco-Ford GAU-7/A required an initial pressure of at least 3,400 psi and hydraulic flow of approximately 40 gpm to drive the gun at 6,000 spm. Four major stoppages occurred during testing; however, the cause of each stoppage was different. No predictable time of parts failure could be established.

Ammunition

The Brunswick 25mm ammunition has a 3,000 grain projectile fully telescoped within its propellant charge. The ammunition was designed to have a maximum chamber pressure of 65,000 psi and to develope a velocity within +100 fps of the design muzzle velocity.

The main components of the cartridge are the forward charge, the aft charge, projectile and its retainer ring, outer shell, primer, ignition charge, front nose positioner, and spacer.

The forward charge is 91.5 grams CIL (Canadian Industries Limited) 1,462 mixed and molded with 5cc ethyl alcohol and acetone. The rear charge is 38.4 grams CIL, 1,462 mixed and molded with 1.25cc of ethyl alcohol and acetone. The projectile weighs 3,000 grains and has a retainer ring of Pyroxylin material. The outer shell is composed of 25 grams of 60 percent felted nitrocellulose, 25 percent acrylic fiber, 15 percent HYCAR resin. The shell is then dipped in 15 to 17 percent acrylic composition. The combustible primer has a (600 milligram, 90 percent felted nitrocellulose and 10 percent HYCAR) and a charge (128.5 milligram, FA 982 primer mix). The ignition charge is 1 gram, Mil-P-223, Class 3 (black powder). The nose positioner is a pyroxylin front spacer (2.2 grams felted nitrocellulose, 85 percent nitrocellulose, 5 percent acrylic fiber, and 10 percent HYCAR resin).

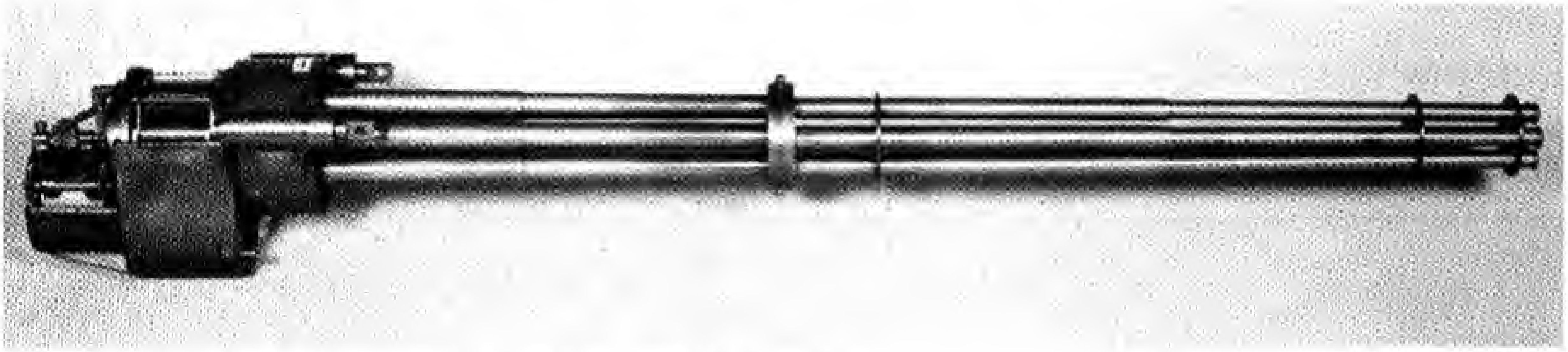
25 MM AMMUNITION
TARGET

25mm Brunswick Projectile for GAU-7/A Philco-Ford (Photo courtesy of Woodin Laboratories)

Chapter 9

25mm GAU-7/A CASELESS AUTOMATIC MACHINE GUN

GENERAL ELECTRIC



25mm GAU-7/A General Electric Caseless Automatic Machine Gun

History

In 1968, a program (Phase I) was initiated to conduct advanced design and development of a 25mm high-rate-of-fire gun capable of firing fully telescoped, caseless ammunition. The program was initiated by the Air Force to fulfill the requirement for a high-performance, air-to-air gun system for the F-15 fighter aircraft. The primary objectives were to: design a weapon for fully telescoped, caseless ammunition; design and develop fully telescoped caseless ammunition; design a linkless feed system; design and fabricate a single shot test fixture; fabricate a one-half scale working model; and prove concept feasibility with 100 round test. These objectives were met by General Electric.

The Phase II program was conducted in 1969 and 1970 to design and fabricate a rapid-fire gun and an associated test feed mechanism, and to continue development of compatible, fully telescoped, caseless ammunition. The primary objective of this program was to prove feasibility of the gun system.

Later in 1970, Phase III was started for further development of the design of a lightweight, 25mm rapid-fire aircraft gun, the test feed system for the gun, and the compatible caseless ammunition. This program included fabrication, test, and delivery of two complete gun systems and 10,000 rounds of ammunition for evaluation tests at Eglin Air Force Base, Florida. These tests were completed in late 1971.

The work on the Phase III GAU-7 culminated with the Eglin Air Force Base tests from July to December of 1971. Subsequently, work ceased on the General Electric GAU-7.

The General Electric feeder was unsolicited. The Emerson Electric feeder was built under another contract. Ammunition work was done by Hercules in Phase I and Phase II, and by Hercules, General Motors, and Olin in Phase III. In addition, AVCO did the warhead development in Phase III.

Description and Purpose

The General Electric design for the Phase III GAU-7/A 25mm caseless ammunition weapon system consists of a six barrel Gatling type gun with ten separate chambers.

The GAU-7/A gun has an overall length of 103.9 inches and weighs 434 pounds. The six 84-inch long

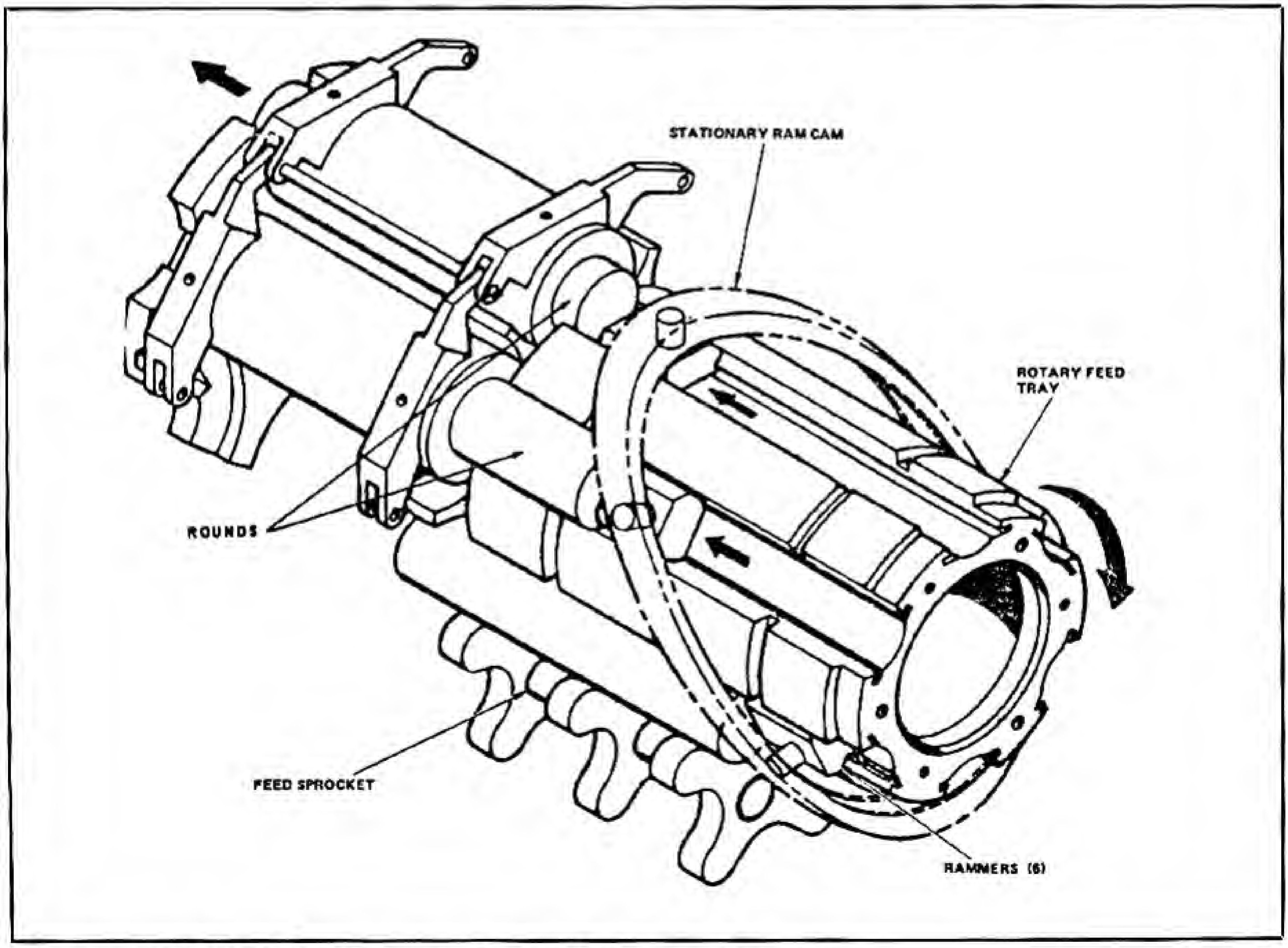
Characteristics

Length	103.88 in.
Width	16.14 in.
Height	20.06 in.
Weight	434 lbs.
Barrel Calibre	25mm
Barrel Length	84 in.
Round Length	6.0 in.
Round Diameter	1.50 in.
Projectile Weight	3,000 grains
Number of Barrels	6
Number of Chambers	10
Rate of Fire	3,000 to 6,000 spm
Motive Power	Hydraulic Motor
Average Recoil Load	4,750 lbs. at 3,000 spm
	9,500 lbs. at 6,000 spm
Maximum Recoil Travel	0.35 in. at 3,000 spm
	0.48 in. at 6,000 spm

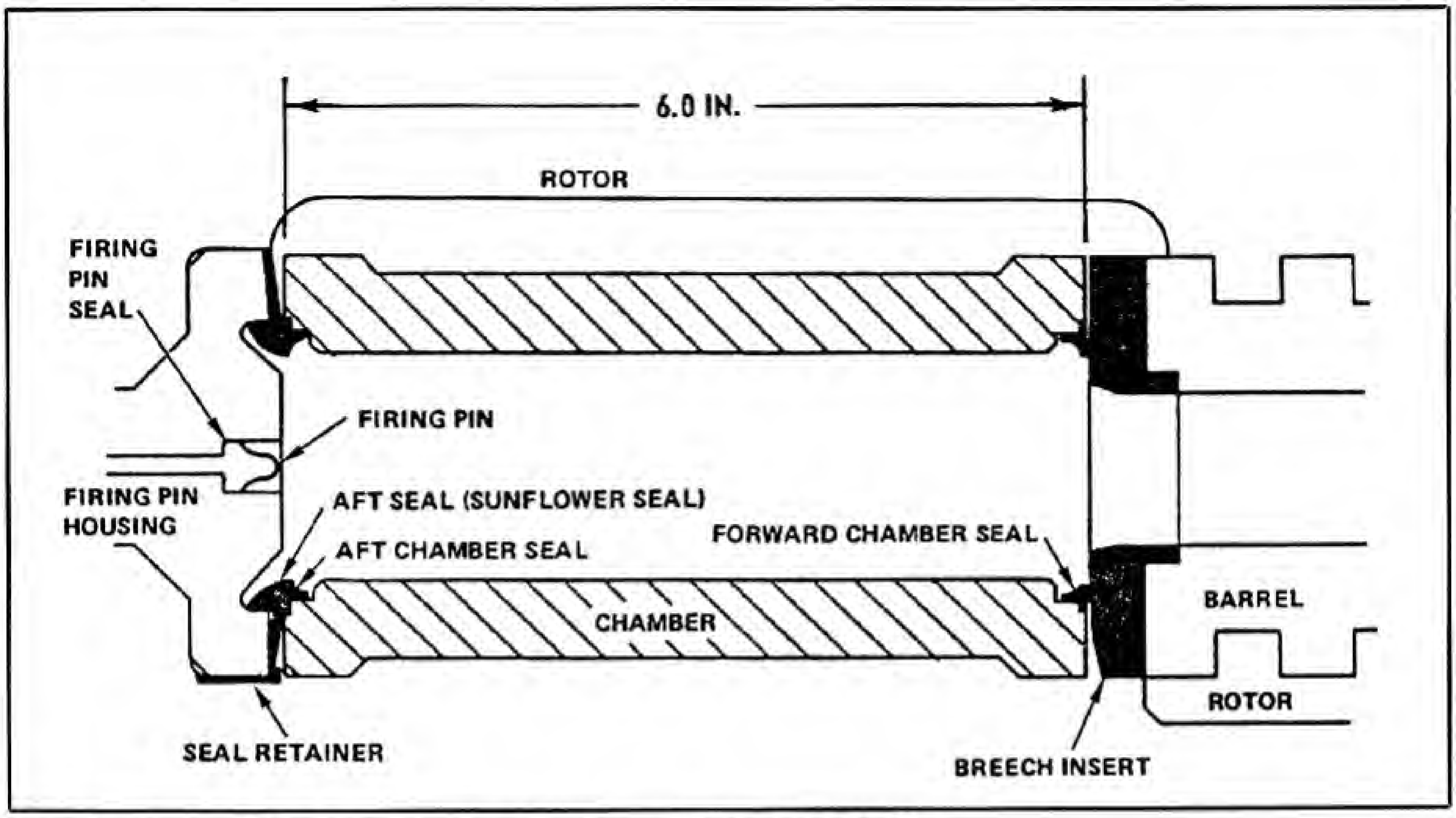
barrels are locked by interrupted threads into a titanium rotor. The rotor has a pocket located behind each barrel which supports and aligns an open-ended cylindrical chamber during the lower 180 degree of rotor rotation. The 10 chambers are linked together fore and aft to form an endless chain, with the rotor acting as a lower sprocket for the chain. Serving as an upper sprocket is the rotary feed tray. The rotary feed tray accepts the rounds of ammunition from the feeder-gun handoff tray and moves it forward by means of rammers controlled by a fixed cam, inserting it into a chamber.

Cycle of Operation

As the gun rotates the chamber moves from the upper sprocket (the rotary feed tray) to the lower sprocket (the main rotor). The chamber is aligned with the barrel in battery position for the lower half of rotor rotation. A spring loaded firing pin is cocked



Operation of the GAU-7/A Feed Mechanism Showing Chambering of Rounds.



Seal, Chamber, and Breech Configuration of the General Electric GAU-7/A Gun.

and released by a ramp on the rotor housing, firing the ammunition. The projectile exits the barrel at about the bottom dead center position of rotation. During firing, the chamber is sealed fore and aft by two circular inserts with a T cross section. The forward seal bears against a replaceable insert in the breech of the barrel while the rear seal contacts a sunflower shaped seal at the rear of the rotor pocket. The T seal is free to move a short distance under the influence of chamber pressure. When the round fires, the increasing pressure forces the forward T seal against the barrel insert, thereby developing the chamber seal. Since the round is caseless with no appreciable residue after firing there is no requirement for an extraction system. However, provision is made to remove a dud round in the event of a misfire. The misfire is pushed forward and out of the chamber by the next incoming round when that chamber again reaches its loading position in the rotary feed tray. The misfired round pushes a spring loaded door open and is picked up by a sprocket handoff system and ejected from the gun.

A 40 horsepower hydraulic gear type motor is used to power the gun and feed system and is supplied by a hydraulic cart through a system of electrically controlled solenoid valves and flow regulators. The hydraulic motor drives the main rotor through a shaft and gear arrangement. The main rotor drives the rotary feed tray through the chain of chambers. The rotary feed tray drives the feeder-gun handoff through a pinion gear at the rear of the feed tray. The feeder gun handoff in turn drives the ammunition feed wheel.

The gun is secured at the muzzle, the mid-barrel clamp, underneath the forward section of the housing and at the left and right recoil mounts. The three forward mounts are designed to permit the gun to reciprocate about 1/2-inch under the control of the two recoil mounts.

General Electric Feed System

The aircraft configuration of the feed system for the General Electric GAU-7/A weapon system consists of two major assemblies, the storage assembly with a capacity of 960 rounds and the transfer assembly. In the proposed installation, the storage assembly is located behind and to the port side of the pilot, with the transfer assembly carrying the rounds from storage to the gun located behind and to the starboard side of the pilot.

The storage unit is 24 inches long, 28 inches wide, and 44.8 inches high. The transfer unit is 24 inches long and 38 inches wide. The weight of the entire storage and transfer system is 281.6 pounds empty and has a capacity of 960 rounds in the storage container.

Emerson Electric Feed System

The Emerson Electric 25mm Ammunition feed and storage system design utilizes a continuous chain of plastic carrier tube elements which follow a controlled path through the storage magazine, through the extractor/pitch expander assembly, and back into the magazine. This system is designed for use with either the Philco-Ford or the General Electric GAU-7/A 25mm Gatling gun.

Test Results

The General Electric GAU-7/A gun was capable of firing at both 3,000 and 6,000 spm after some modifications had been made during the test. The gun acceleration to rate varied between 290 and 564 msec. The gun deceleration ranged from 508 to 2,160 msec.

The GAU-7/A gun could not reliably fire a 150-round burst at either high or low rates of fire.

The General Electric GAU-7/A gun demonstrated that it could eject misfired rounds, but the ejection process frequently damaged the gun.

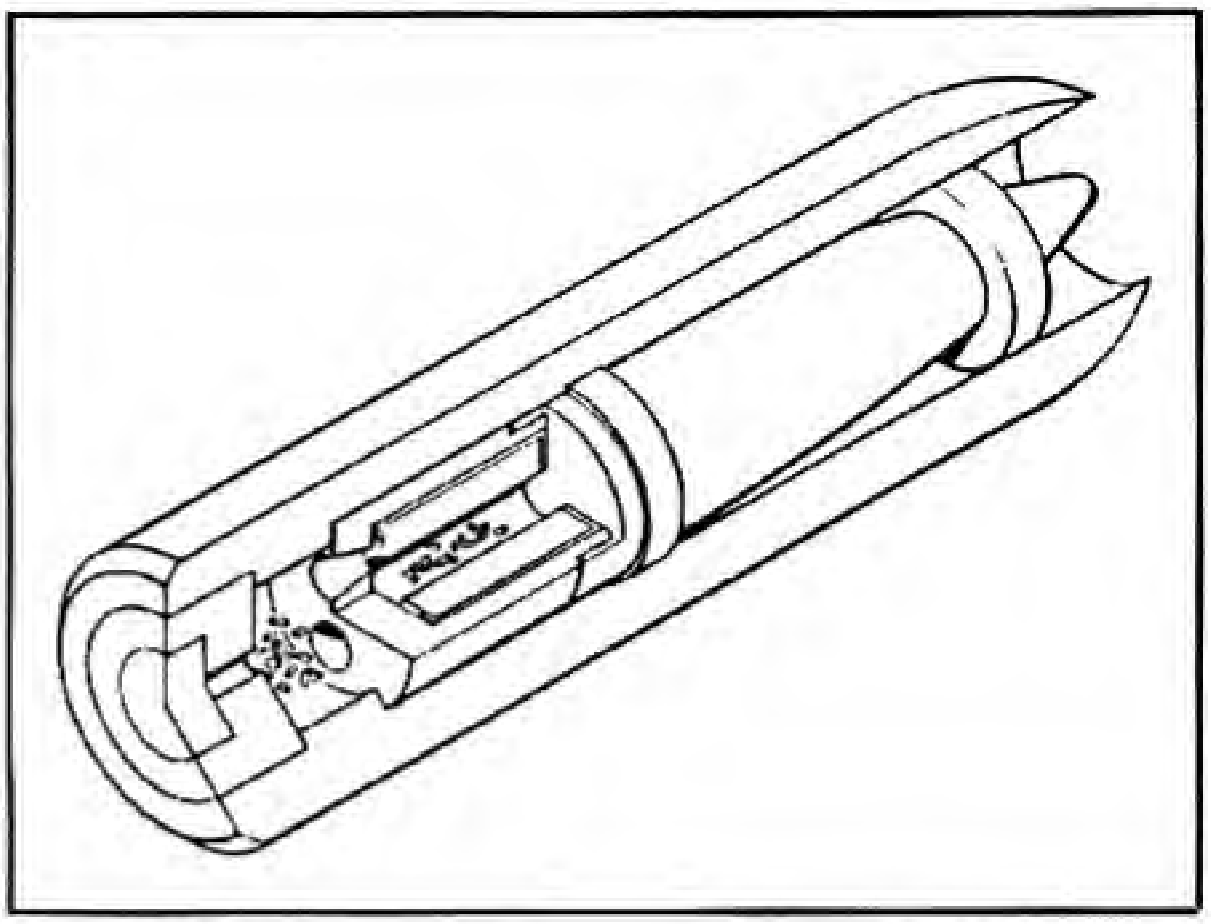
Information was gathered on barrel and seal life. Insufficient rounds were fired to enable wear data for other parts to be determined.

The United States Air Force comparative test of the Phase III GAU-7 guns was published in May 1972 and based on the results of that test the Philco-Ford GAU-7 was selected for further development and the General Electric GAU-7 development ceased.

Hercules 25mm Ammunition

The Hercules 25mm ammunition for the General Electric GAU-7/A gun is a 3,000 grain projectile fully telescoped within its propellant charge. The ammunition is designed to have a maximum chamber pressure of 65,000 psi and to develop a velocity within +100 fps of the design muzzle velocity. The action time (period from hammer fall until projetile leaves barrel) is designed to have a mean time of 12 + 1.2 msec. The flame temperature during firing is designed to be 2,800° K.

The complete caseless round has the shape of a right circular cylinder with a length of 5.960 inches and a diameter of 1.515 inches. The weight of the complete round is 0.731 pounds.



Projectile Design

Combustion is initiated when the firing pin strikes the primer at the rear of the round. The primer ignites a booster charge which forces the projectile out of the propellant case and forward into the barrel. A copper rotating band around the rear section of the projectile engages the barrel lands, sealing the chamber. The booster ignites the cylindrical propellant charge which builds up chamber pressure discharging the projectile from the gun.

The main propellant charge consists of 124 grams of HES 8381, a granulation of Hercules propellant, which is molded into shape using a 50-50 percent solution of alcohol and acetone. This charge is coated with HES 8028 Blue and then wrapped with a protective, .0015-inch thick by 5.42 inches wide polyester tape covering. The combustible primer consists of a molded primer cup housing of HES 2400 filled with FA 982 priming mix. The booster is a 28 gram charge of Class 6 black powder per MIL-P-223. The retention ring is composed of HES 8560, .065-inch thick, and the base plug is made of HES 8381.

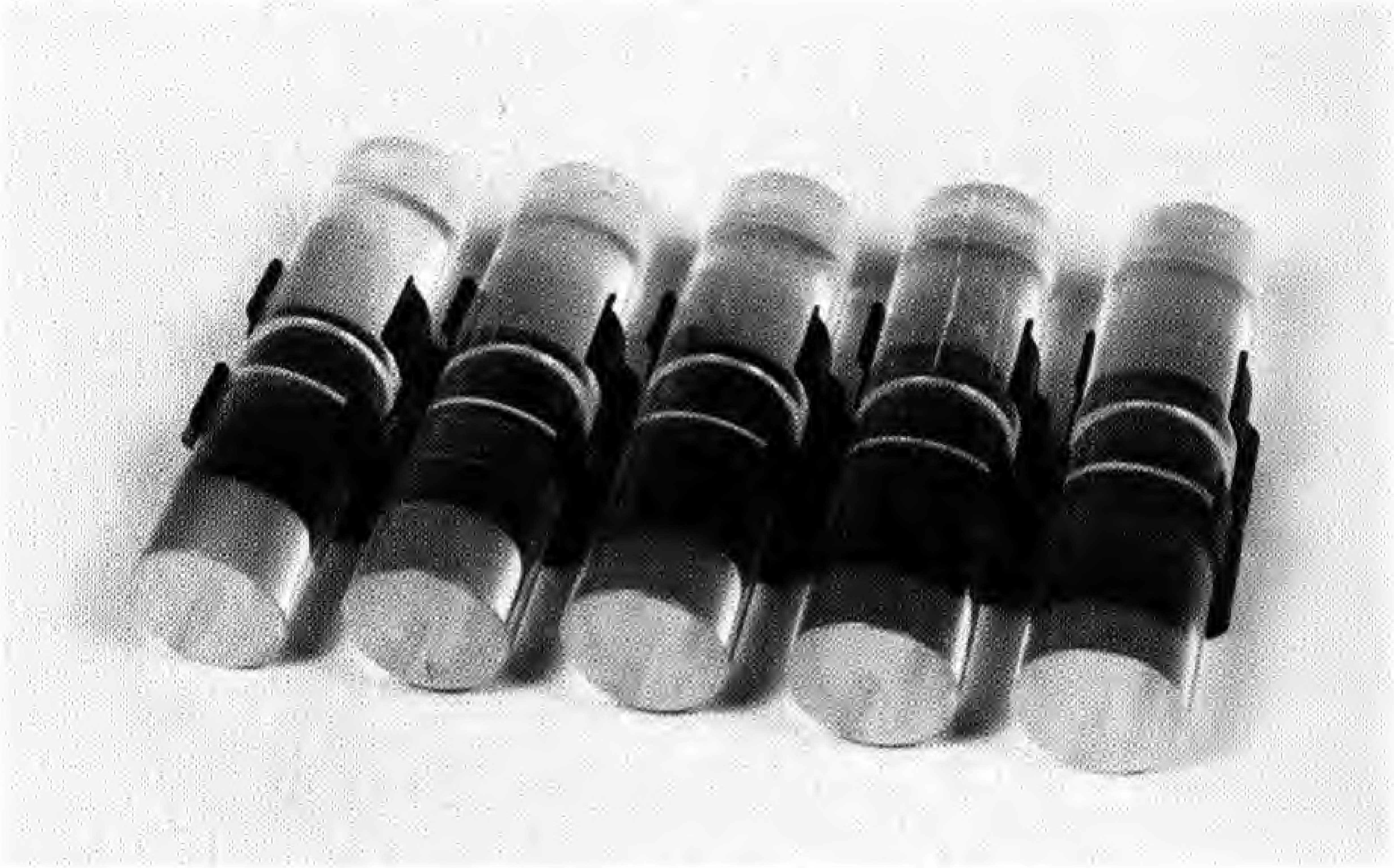
Ammunition Tests

The 25mm caseless ammunition developed by the Hercules Corporation was generally found to exhibit consistant performance characteristics. The existance of occasional high pressure rounds with greater than 80,000 psi peak chamber pressure was a major shortcoming, however, of the Hercules design.

The round was found to be quite durable as experienced during the Five-Foot Drop tests, but when subjected to abnormal multi-shot gun handling loads the round would break apart into pieces and propellant granules. These small pieces of propellant were very easily ignited when exposed to sparks of flame.

The performance and the physical condition of the round were most adversely affect by the 10-day humidity conditioning environment. This indicates the need for the development of a better protective coating and wrapping. A high temperature conditioning environment was found to speed the ignition process of the round during firing while the cold temperature conditioning retarded the round ignition process.

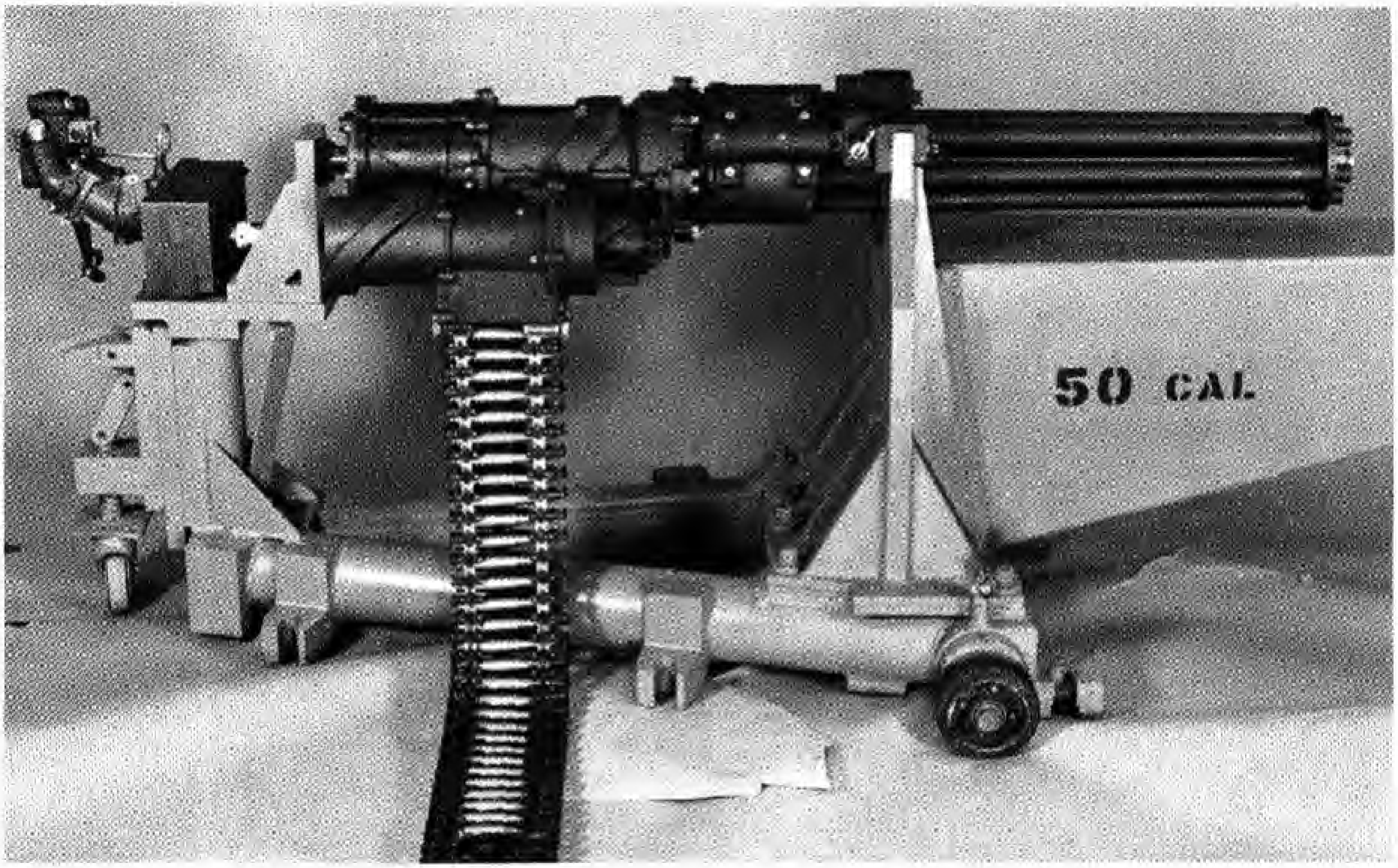
The Hercules round performed with very little blow-by and produced only small amounts of residue when fired from both the single-shot test fixture and the General Electric multi-shot gun.



25mm Caseless Ammunition for General Electric's GAU-7/A Caseless Automatic Machine Gun.

Chapter 10

CALIBRE .50 GAU-6 GATLING GUN
GENERAL ELECTRIC



Calibre .50 GAU-6 Gatling Gun

History

This project was done during the period February 1968 to July 1970, by General Electric under contract to design a calibre .50 gun. The purpose of this effort was to design, develop and test a high rate-of-fire aircraft machine gun of approximately 10mm calibre based on the Gatling principle of operation. The gun was intended for use as an internal installation in tactical aircraft and was to be employed in air-to-air and air-to-ground firing. The end result was to be an externally powered gun capable of being mounted in a variety of military aircraft and capable of firing a high velocity round at a rate of two to three thousand rounds per minute higher than now available.

The initial effort consisted of an engineering analysis of the technical requirements, a study of existing weapon design features, and formulation of an engineering plan and a schedule. The plan was to design, fabricate, and test the gun in a calibre .50 version and then convert it into a 10mm weapon. This was done to allow testing of the gun design before the 10mm ammunition was fully developed. Although it was planned to initially design a calibre .50 version, the 10mm round characteristics were used as design parameters. The paper design (including layouts and drawings) was completed and a development model was fabricated. Initial testing of the calibre .50 gun was then completed.

Description and Purpose

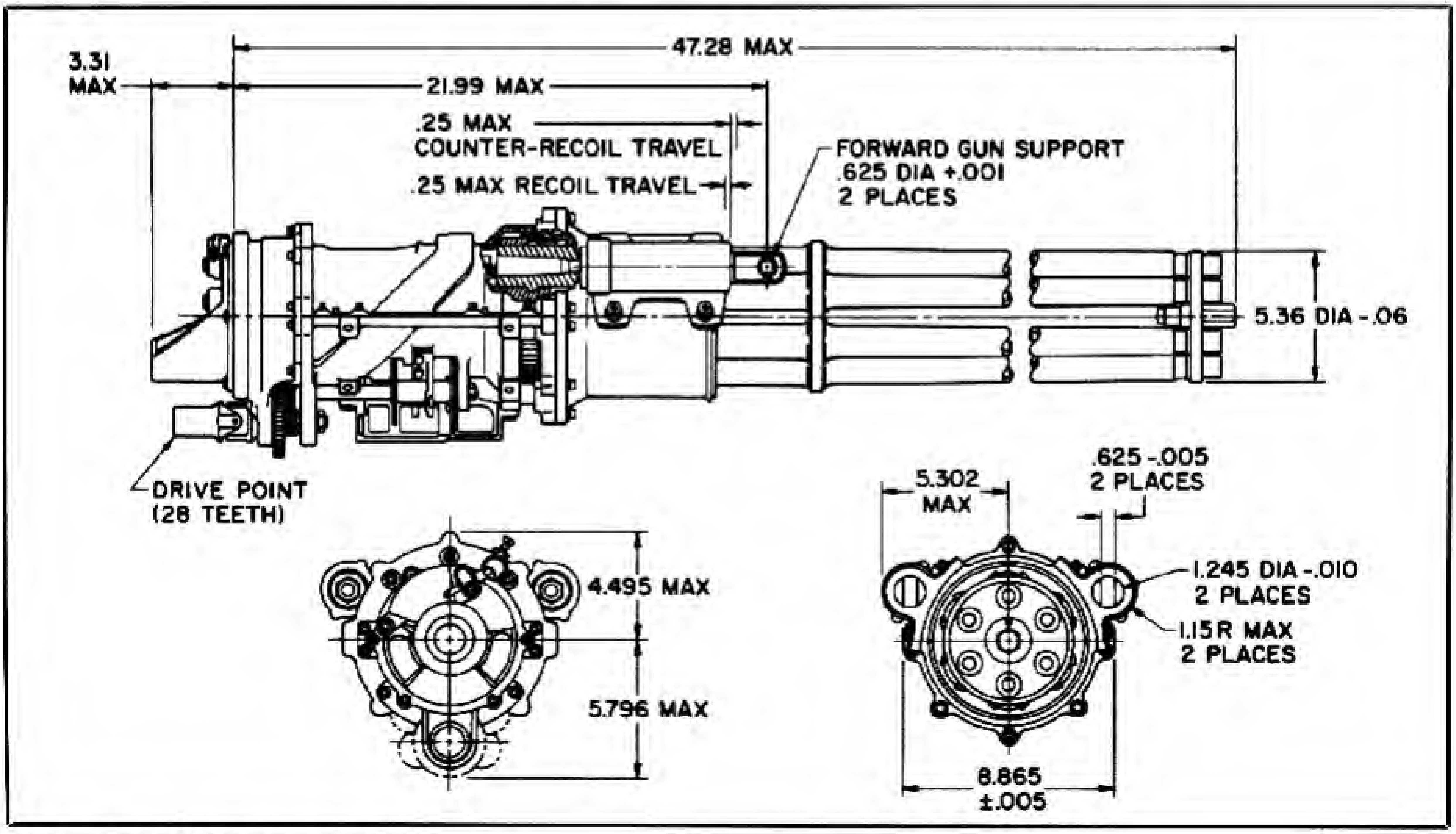
This weapon was to fire a special 10mm cartridge but since the cartridge development was not successful, the gun was built to fire standard calibre .50 ammunition.

The calibre .50 Gatling was designed to provide a lightweight, high rate-of-fire gun for air-to-air combat. The design allows selectable firing rates of up to 10,000 shots-per-minute and also is designed to fire high pressure, high velocity, aluminum cased ammunition which had not yet been developed. While the gun was designed for 8,000 spm; testing was limited to 4,500 spm due to link strength. Until a linkless feed system is developed to support the higher rates, the gun cannot be fired above 4,500 spm. Then a minimal effort was expended while awaiting completion of the 10mm round development. The contract was later modified to delete the 10mm requirements and establish requirements for completion of the gun as calibre .50.

One unit was constructed.

Characteristics (Predicted)

Gun:	
Length	50.6 in.
Width	10.6 in.
Height	10.3 in.
Weight	160 lbs.
Number of Barrels	6
Gun Life	250,000 rounds
Barrel Length	36 in.
Ammunition	0.50 cal., M17 tracer, M20 APIT, M23, M33 ball, M8 API
Method of Operation	Gatling type, externally powered
Feed System	Linkless
Rate of Fire	Selectable to 8,000 spm Selectable to 10,000 spm with 7 bbls.
Muzzle Velocity	2800 - 3450 ft./sec.
Power Required (Estimated @ 8000 spm)	18.6 hp
Reliability	100,000 MRBF


3.31 MAX
47.28 MAX
21.99 MAX
.25 MAX COUNTER-RECOIL TRAVEL
.25 MAX RECOIL TRAVEL
FORWARD GUN SUPPORT .625 DIA +.001 2 PLACES
5.36 DIA -.06
DRIVE POINT (28 TEETH)
4.495 MAX
5.796 MAX
5.302 MAX
.625 -.005 2 PLACES
1.245 DIA -.010 2 PLACES
1.15R MAX 2 PLACES
8.865 ±.005

Calibre .50 GAU-6 Gatling Gun

Cycle of Operation

The gun operation was similar to that of the M61A1 Vulcan. Each of the gun's six barrels fired only once during each revolution of the barrel cluster. The barrels were attached to the gun rotor by interrupted threads and no headspace adjustment was required. The gun rotor was journalled within a stationary outer housing and contained the six gun bolts. The bolts slide fore and aft on tracks and provide the ram, lock, fire, unlock, and extracting functions. The stationary outer housing included a main cam which drives the bolts through their respective functions.

The basic difference between the M61A1 and the calibre .50 Gatling is the method of bolt locking. The calibre .50 Gatling uses a rotary lock while the M61A1 uses a drop lock.

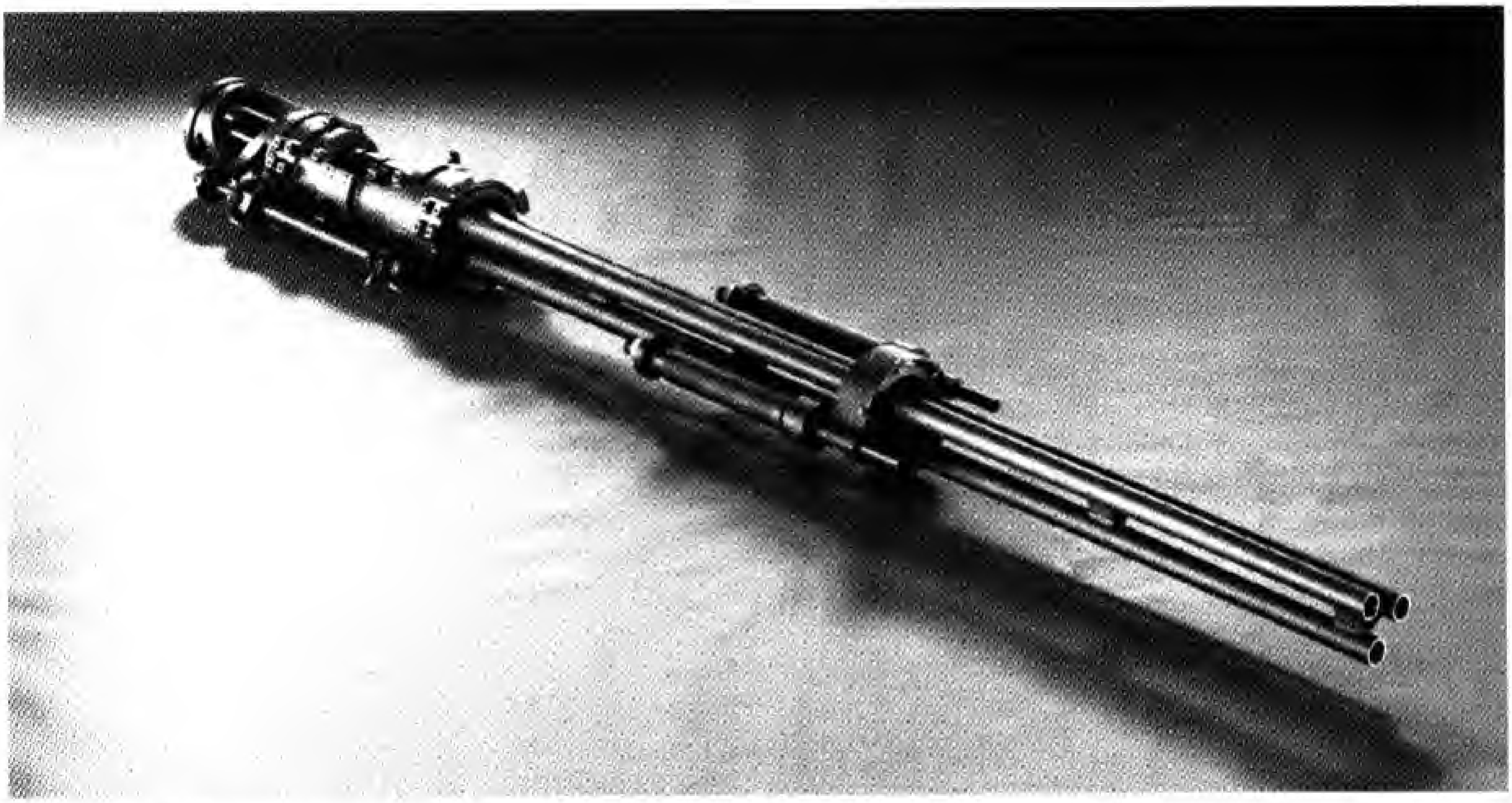
Test Results

Over 30,000 rounds have been fired from the gun and the tested reliability at 20,000 rounds was about 4,500 MRBS for the gun and 6,000 MRBS for the feeder.

Chapter 11

30mm CHAG MACHINE GUN (Compact High Performance Aerial Gun)

GENERAL ELECTRIC



30mm CHAG (Compact High Performance Aerial Gun)

History

The General Electric Company was under contract to the United States Air Force Armament Laboratory, Eglin Air Force Base, for development of a Compact High Performance Aerial Gun (CHAG). General Electric's CHAG is a very compact, lightweight, 30mm high rate-of-fire weapon, operating on a modified Gatling cycle. Numerous highly innovative features have been incorporated to reduce overall gun profile and weight.

The major features of the gun are a welded barrel cluster, forward and aft bolt control cams, the ability to mount recoil adapters on the barrels or on the gun housing, and reverse clearing similar to GAU-8/A. Weighing less than 280 lbs. (127 kg), the CHAG fires all standard GAU-8/A ammunition with identical ballistic performance and armor penetration capability.

Description

The CHAG is externally powered, using the hydraulic drive and controller designed for GAU-8/A-Phase 1. Also, the GAU-8/A transfer unit (slightly modified), turnaround unit, fixed and flexible chuting, and conveyor elements were used in a 120-round feed loop to feed CHAG during all testing. All this test equipment, plus CHAG, is reversible for automatic reverse clearing as with the GAU-8/A gun.

Cycle of Operation

The CHAG was mounted on its flat table test stand by four axial slides (two forward on the gun housing and two to the rear). Two recoil adapters were attached to the barrel cluster mid-length radial support. The CHAG was mounted with its eject and feed parts upward for interfacing with the transfer/turnaround units and the feed loop. This orientation put the firing sector at the bottom of the gun in a 5 to 7 o'clock position. Gun rotation is counterclockwise as viewed from behind the gun axially.

Hence, the barrels, the rotor, and the bolt assemblies all rotate inside a fixed stationary gun housing. One barrel fires at a time, and each barrel fires in turn as the cluster rotates each barrel individually through the firing sector.

There are three gun bolt assemblies—one for each barrel. The bolts ride in axial slots in the rotor, directly behind each barrel. As the barrel cluster and rotor rotates, the three bolts also rotate.

The bolts also move fore and aft in their individual rotor slots. A bolt is moved to the rear and a cartridge is placed in front of it in its rotor slot. This bolt is then moved forward and, in so doing, it pushes the cartridge into the barrel where it is fired. After firing, this same bolt extracts the empty cartridge case out of the barrel. The bolt and case are moved to the rear of the gun where the case is removed from the rotor slot.

Characteristics

Type	Externally powered lightweight 3 barrel modified Gatling, 30mm
Length	121.6 in.
Diameter at Muzzle	4.7 in.
Width	8.9 in.
Height	11.8 in.
Weight	280 lbs.
Firing Rate	2000 shots-per-minute
Barrels	3 barrel welded cluster
Power to Drive	External, 40 HP (30 kw)
Ammunition	Standard 30-mm GAU-8/A API, HEI, TP
Muzzle Velocity	3400 ft./sec., HEI 3240 ft./sec., API
Dispersion (80% of rounds fired)	5 mils
Recoil Force:	
Peak, Max.	11,000 lbs.
Peak, Recurrent	7,000 lbs.

On the inside of the stationary housing there is a cam. A roller on top of the bolt rides in this cam. As the rotor/bolts are rotated, the rollers acting on the cam, force the bolt forward (for chambering) or rearward (to extract). All this action of rotating and forward/ rearward bolt motions take place continuously, so that, for example, as one bolt/barrel is firing in the firing sector, one bolt is starting to ram in a new cartridge, while the third is traveling rearward in the extraction mode.

Where the CHAG becomes different is in the housing cam that was found to have an excessively steep ram and extract angle due to the small diameter of the housing. The bolts could not be rammed/ extracted against this steep angle. A new device was needed to provide these functions.

The new device was conceived to be the rear drum cam. It contacts rear rollers on the bolts so, as this drum turns, it forces one bolt forward and pulls the second bolt rearward while the third bolt is in the firing sector. The three bolts and barrels are at 120-degree angles to each other. As they continue to rotate, they will experience individually, in turn, all the features of the gun cycle: feed, ram, lock, fire, unlock, extract, and eject.

The rear drum is geared to the rotor. It turns in the opposite direction as the rotor and three times as fast. In fact, it makes one revolution for each round fired. It has a ram cam and an extract cam, plus provisions for forward dwell (firing sector) and rear dwell (eject and feed). These cams cross near their mid-stroke, so a shoe is placed on top of the rear bolt roller to carry the roller through the cam's crossover.

The housing cam which had the steep angles still does some work. It has four corners (two acceleration and two deceleration) which exist in the housing. The forward rollers on the bolts act against these corners. These corners provide the first part of the bolt's motion (acceleration) and the last part of the bolt's motion (deceleration). The in-between bolt motion is provided by the rear drum. There are no switches, gates, or moving parts. The housing cam corner starts the bolt moving forward. After about 1½ inches of movement, the rear bolt roller contacts the rear drum cam and gets about 1½ inches from forward dwell. Now the bolt's forward roller contacts the housing deceleration corner and controls the bolt while the rear drum cam comes to an end.

At the top of CHAG is the rear dwell where the empty case is removed from CHAG, and where a new cartridge is placed into the gun and in front of the same bolt that just previously ejected an empty case. The transfer unit sits on top of CHAG. It has two sprockets (one feed and one eject) geared to the rotor. The eject sprocket takes the spent case from the gun, and the feed sprocket puts a new round in front of the same bolt. The turnaround unit sits on top of the transfer unit and is geared to it. This unit has one sprocket. Around this sprocket is the belt of conveyor elements that extend outside this unit into the 120-round loop. This sprocket with proper scoops takes a new cartridge from the incoming conveyor elements and delivers it to the transfer units feed sprocket. In like manner the transfer's eject sprocket hands off the spent case to the turnaround sprocket where the case is put into the empty conveyor element, which exits the turnaround unit and enters the feed loop. This action is continuous and fully reversible for reverse gun clearing.

To move the empty case radially out of the rotor slot, gun followers were designed. The followers sit in recesses in the rotor slots. At the right time this follower (there are three followers) lifts from its recess, contacts the empty case, and pushes (paddle fashion) the case radially out of the slot and onto the transfer unit's eject sprocket. The follower remains extended and receives the new round from the feed sprocket. It places the new round gently down into the rotor slot just before ram begins. A radial cam in the housing pushes against a roller and push rod to actuate the follower outward, and then controls its inward motion during feed.

The bolt has a fixed groove on the bottom of its bolt face. This groove engages the cartridge extractor groove during feeding and ties the cartridge and bolt together for the entire gun cycle until the fired case leaves at eject.

Prior to firing, the bolt assembly is locked to the rotor with wing locks (one on each side of the bolt) that are contained in recesses in the rotor slots. After firing, the wing locks are opened. The mechanism for closing and opening the wing locks is contained in the bolt assemblies. This mechanism is operated by a fixed stationary cam in the housing, and this operation is completely reversible.

This housing lock/unlock cam contacts a slide on the bolt to move to the rear during lock and forward during unlock. This happens by means of a roller attached to the slide that contacts the cam. As the slide moves rearward, the slide forces two actuators outward (also on the bolt-one left-one right). The actuators contact their wing locks to the rear of the wing lock pivot. This causes the wing locks' forward ends to move into recesses on the bolt-one each side. The lock action is then completed, and the wing locks are in place in the bolt recesses and ready to receive the firing impulse and transfer it to the rotor. Before firing, however, the slide continues to the rear. The front end of the slide then captures each wing lock and retains them so that they cannot bounce open inadvertently.

For unlocking, the cam forces the slide forward. The forward end of the slide contacts both wing locks and forces them open. The actuators are retracted.

The firing pin is also controlled by another area on the lock/unlock cam. A solenoid sits on this cam and controls a moving sector that moves into and out of the cam. When the sector is in (solenoid not energized), the firing pin cannot drop. The reverse is also true. So firing starts when the solenoid picks up its sector and the hydraulic drive starts turning the gun. The firing pin and tang (contained on the bolt) strikes the cocking surface on the cam and is prevented from going forward as the bolt completes its forward travel. A firing pin spring on the bolt is energized by the differential motion of firing pin to the bolt. As the bolt reaches its forward-most position, this spring is fully charged. The bolt now merely rotates with the rotor without fore/aft motion while the wing locks are closed. While this is happening, the firing pin tang which engaged the cam earlier is also riding rotationally (with the rotor) with respect to the fixed cam. At the proper rotational displacement on the cam, the tang engaging surface is discontinued. This allows the tang and firing pin to move forward under the energy stored in the firing pin spring. The firing pin strikes the cartridge primer, and the round is fired.

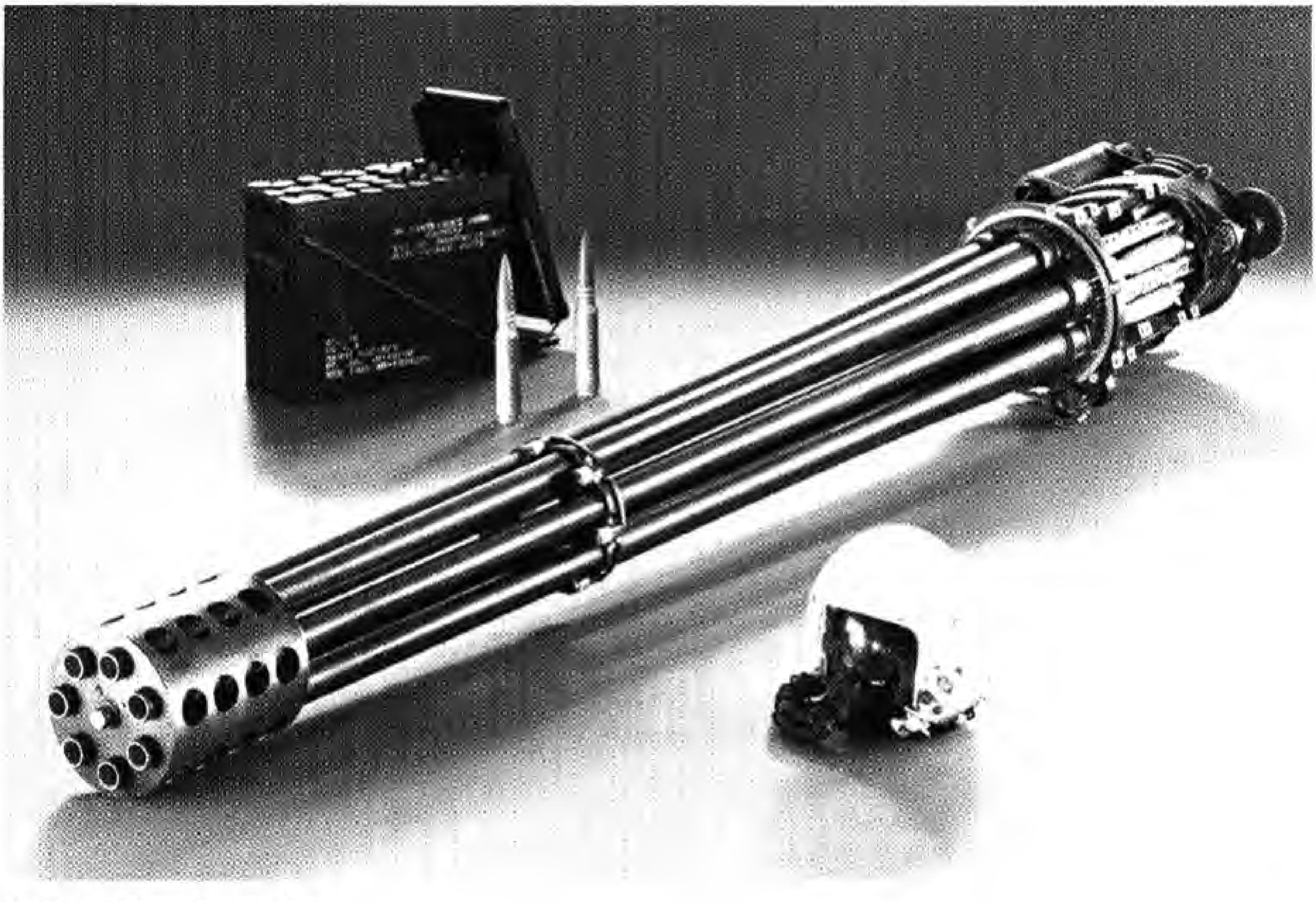
For reverse clearing, the sector is moved into the cam by a spring after the solenoid is deenergized. The sector makes the cam cocking surface continuous so that the firing pin tang can move rotationally without dropping forward toward the primer. A safety pin keeps this sector in (closed) during maintenance actions.

There is another safety device to keep the firing pin from extending into a primer during all gun phasing except when the wing locks are closed in the firing sector. This device is two pivoting retainers contained on the bolt. When these retainers are closed, they physically get in front of a shoulder on the firing pin and prevent the pin from extending. The retainers are opened by the wing.

Chapter 12

30mm GAU-8/A AVENGER GUN

GENERAL ELECTRIC



GAU-8/A 30mm Gatling Gun

Introduction

The Avenger 30mm Gun is a "BIG" gun. It has seven barrels, and it weighs 700 pounds. Each barrel is 86 inches long and weighs 51 pounds. It fires the 30mm cartridge which is 11.4 inches long.

The Avenger arms the U.S. Air Force A-10 Close Air Support Aircraft that defeats tanks and was first operational in 1976. To assure a well-done job, the A-10 carries 1350 30mm cartridges and fires at 4200 shots per minute (spm).

The Avenger was derived from its little brother, the Vulcan 20mm gun, that weighs only 260 pounds. The Vulcan was in full operational use by the U.S. Air Force F-105D Fighter in 1960. The little Minigun 7.62mm—just 65 pounds—being of the same gun family was operational in Southeast Asia in 1965.

The Avenger, the Vulcan and the Minigun are all Gatling guns. They all have multi-barrels that form clusters that rotate up to 1000 revolutions per minute. They can produce immense fire power of 6000 spm (100 shots per second).

Richard J. Gatling is to be thanked for this revolutionary, high speed, rotary principle of operation that he patented in 1862. Likewise, the U.S. Military and U.S. Industry deserve honors for capitalizing on Gatling's simple invention by designing it into today's most formidable weapons.

History

During World War II, the German Luftwaffe deployed tactics developed previously by U.S. Military Air Forces for dive bombing and close air support. The Germans mounted heavy calibre guns in their aircraft to combat heavy armor on their Eastern Front. These operations proved successful by using the mobility of their aircraft to break up massed armor behind the lines before it could strike.

The need for U.S. Military to update these tactics became apparent when the Warsaw Pact nations acquired a five to one advantage in heavy armor over NATO in Central Europe during the mid 1960's.

At General Electric, in May 1968, an Independent Research and Development Study Project was started for the purpose of examining the requirements of a close air support armament system together with the U.S. Air Force Weapons Development Center at Eglin Air Force Base, Florida. Designs for a 30mm gun resulted, and by June 1970, an Engineering Test Unit Weapon was built. It was made ready for tests and was first fired in December of 1970.

In late 1970, the Air Force contracted General Electric and Philco-Ford each to develop, fabricate, test and deliver the Air Force three 30mm close air support armament systems for the YA-10 aircraft.

A third armament system was built by Eglin Air Force Base that used two Oerlikon 304Rk Revolver Guns 30mm. Each gun used a four chamber revolver and fired at 1350 spm.

The two guns were installed on one pallet that was designed to fit into the gun bay of the YA-10. The system was recalled by Eglin Air Force Base before the start of tests of the Philco-Ford and General Electric systems.

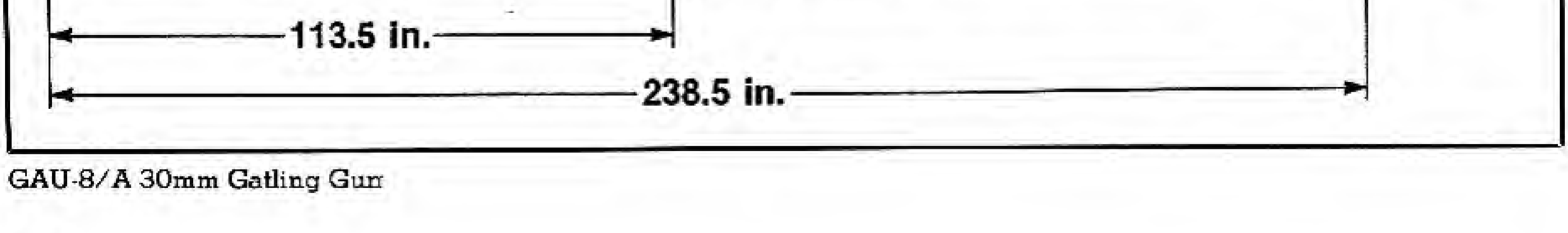
The competitive evaluations were conducted at Eglin Air Force Base. They included extensive ground fire tests during the first quarter of 1973. By April of 1973, the Air Force announced that the General Electric system had won the shoot-out competition.

The first installation of the prototype armament system was made in the YA-10 at Edwards Air Force Base by March 1974. Flight tests started and were successful so that the Air Force started production manufacturing at General Electric during September 1974.

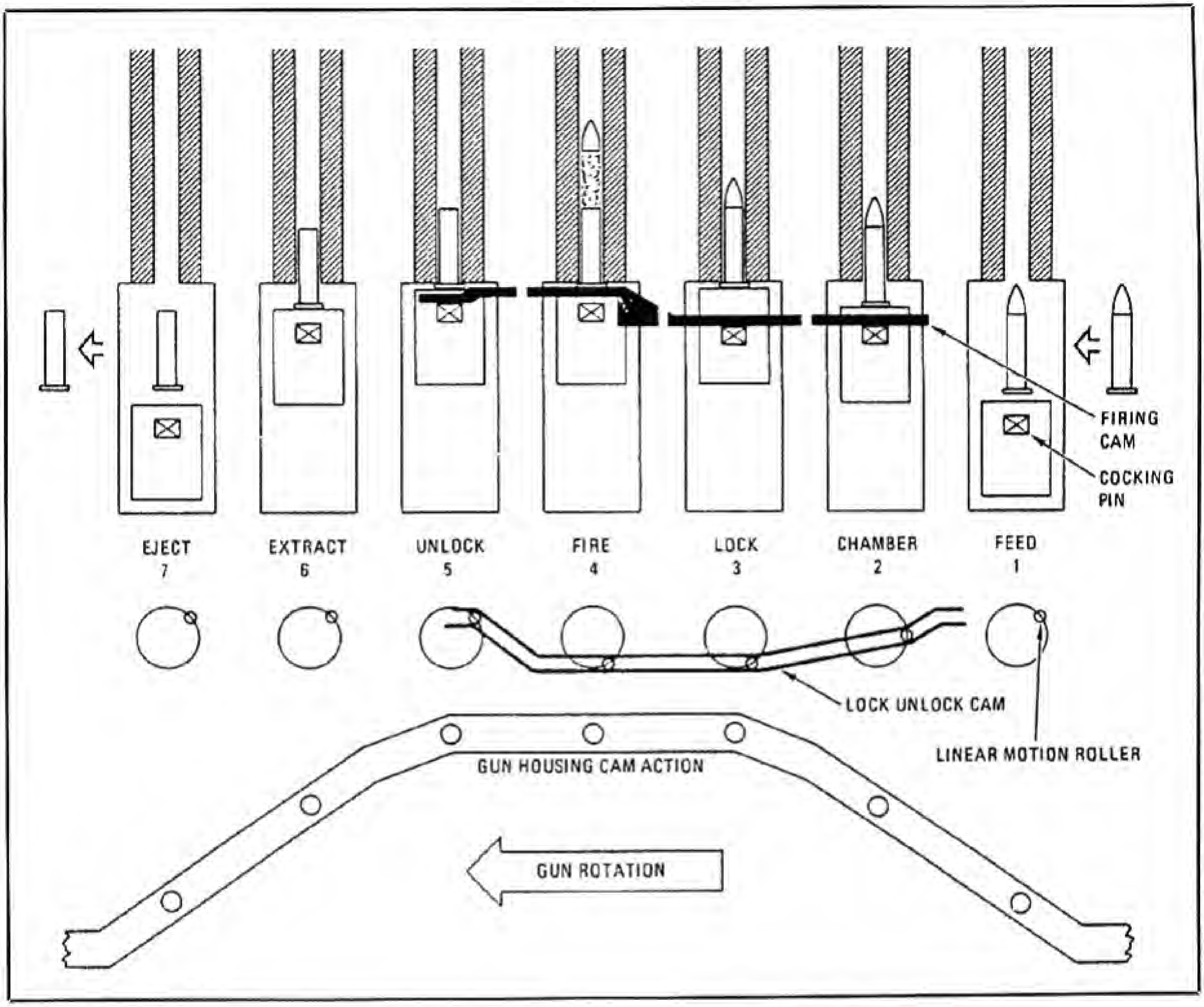
The first Avenger GAU-8/A production system was fired at General Electric during August of 1975 and then installed in a production A-10 aircraft. The A-10 was operational in 1976. Since that time, there have been 700 Avenger GAU-8/A Armament Systems manufactured at General Electric with deliveries terminating in November 1983. By 1986, some manufacture continues for spare parts and spare guns.

Avenger Operation

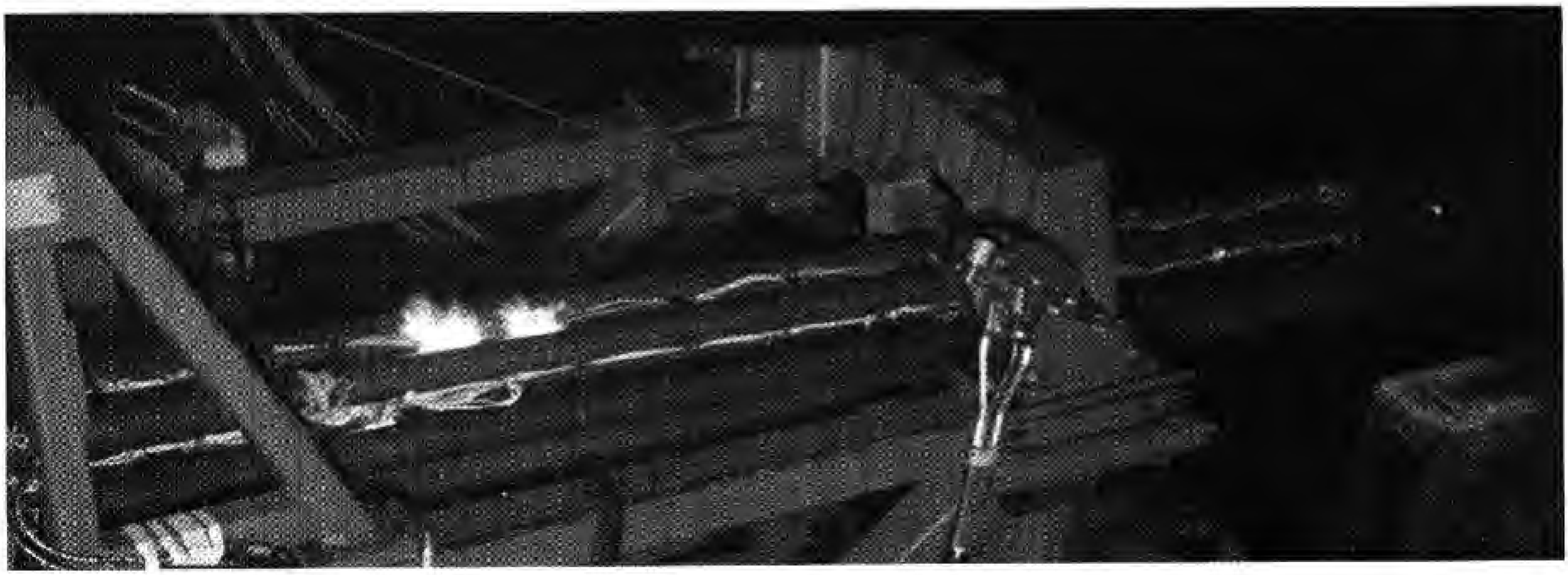
Firing Cycle. The Avenger operates on the Gatling principle. Its seven barrel cluster rotates continuously during firing. Only one barrel fires at a time, as it is rotated toward the top fixed location of the gun.



GAU-8/A 30mm Gatling Gun


FIRING CAM
COCKING PIN
EJECT 7
EXTRACT 6
UNLOCK 5
FIRE 4
LOCK 3
CHAMBER 2
FEED 1
LOCK UNLOCK CAM
LINEAR MOTION ROLLER
GUN HOUSING CAM ACTION
GUN ROTATION

Cycle of Operation



GAU-8/A 30mm Gatling Gun

The barrel keeps moving as the firing pin is released, the propellant is ignited and the projectile leaves the muzzle. The breech pressure then declines, and unlocking of the gun bolt starts. All this action takes about 50° of rotation of the barrel (and the cluster).

The barrel that is following starts the same firing cycle. It fires and rotates through the same 50° firing sector to be unlocked. Each barrel that follows, then, goes through the same routine, and so on, so that each barrel is fired one at a time and in turn as the cluster rotates.

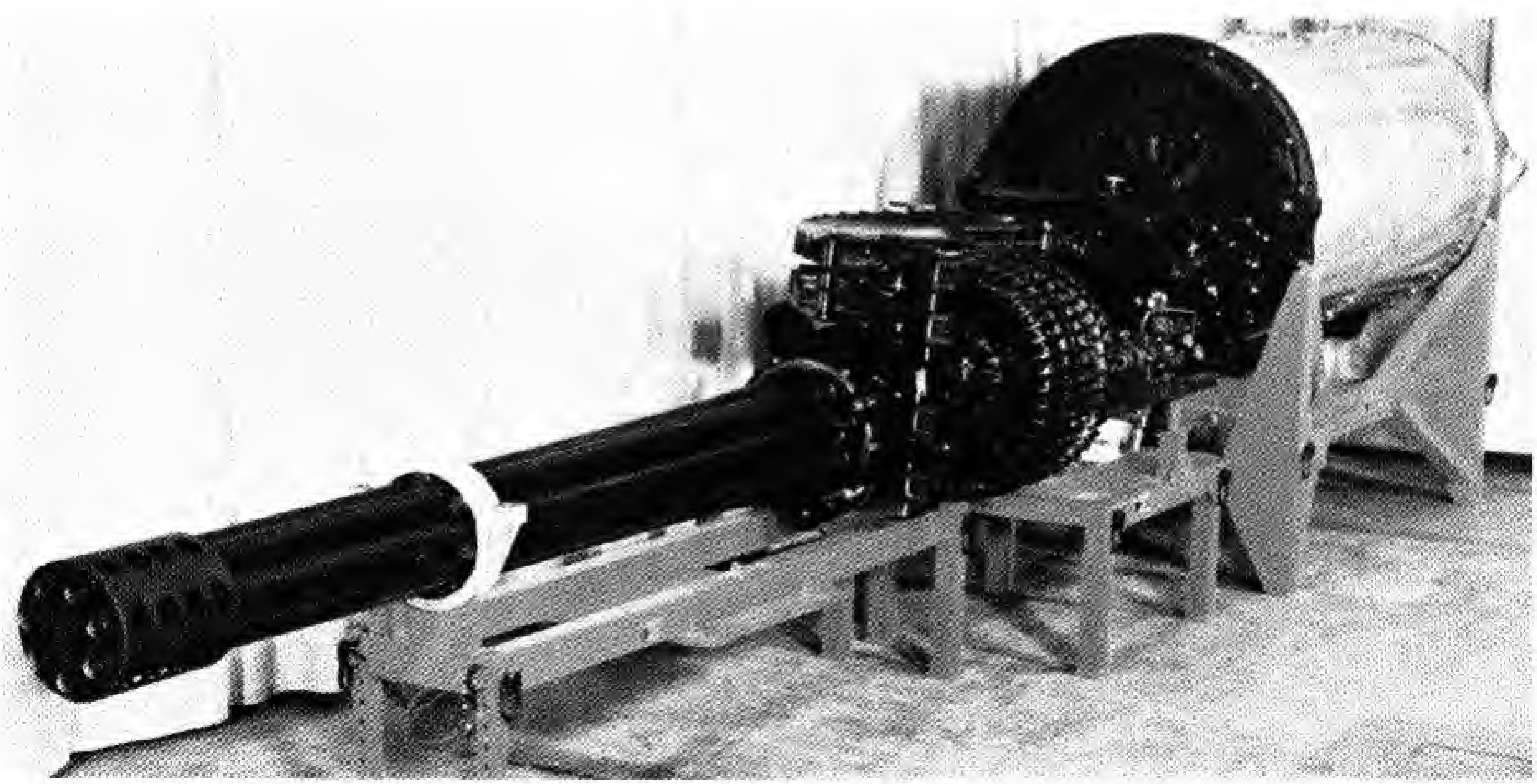
Gun Bolts. Behind each of the seven barrels are seven gun bolts (one for each barrel), which initially carry new ammo from the feeder to the barrel. After chambering the new ammo, the gun bolt extends its firing pin and fires the ammo. Slightly before firing the gun bolt locks itself and closes the breech. After rotating through the 50° firing sector the bolt unlocks itself and extracts the empty case from the barrel chamber. Now at the rear of the gun, the bolt will eject the empty case out of the gun via the guide bar. The gun bolt will then rotate to the feed location for a new cartridge and repeat the cycle.

The cycle is feed, ram, lock, fire, unlock, extract and eject. Each of the seven gun bolts is experiencing one of these functions at the same time, and changes to the next function as the gun rotates.

Elliptical Housing Cam. The gun bolts rotate with the barrel cluster being restrained by the trackways of the rotor, but being able to slide fore and aft in these trackways. A roller on the bolt rides in a somewhat elliptical cam in the fixed gun housing. So, as the rotor turns the gun bolts are forced forward and rearward by the cam. The bolts perform the gun cycle functions as they pass the fixed locations of these functions on the gun housing elliptical cam. (The cam only appears elliptical).

Lock and Unlock Cam. A cam is attached to the inside of the gun housing. This cam actuates the lock and unlock features of the gun bolt by forcing the cam follower at the rear of the bolt to rotate the bolt head to lock and to reverse rotate the head to unlock.

Safing and Cocking Cam. The cocking pin makes contact with a cam inside the gun housing before the round is fully chambered. As the gun bolt continues to chamber the round, the firing pin spring starts to cock, and is fully energized when chambering is complete and breech locking starts. At the end of locking, the cocking pin falls off the sear and is driven forward by its spring to stroke the primer and fire the round. The safety and cocking cam can be closed off by a solenoid to stop firing, and to cam the firing pin across the cam during reverse gun clearing at the end of the burst.



GAU-8/A 30mm Avenger Armament System

Gun Bolt Description and Operation

The Avenger's gun bolts are made up of three components: the bolt head and firing pin, the bolt body and cam follower, and lock-unlock cam follower. When assembled these components are held together by two roll pins, so that the complete gun bolt is a secured assembly when free of the gun, and the pins are in place. The bolt is inserted into the gun (and removed) as a complete assembly.

The gun bolt body has four tracks, two forward and two rear, used for keeping the bolt secured to the rotor while the bolt is in the gun. The tracks slide in the rotor's trackways. On top of the bolt body is a roller that is held to the body when the capped restraining shaft is inserted into the body and pinned. The roller rides in the main elliptical cam and is used to direct the gun bolt fore-aft during the gun cycling.

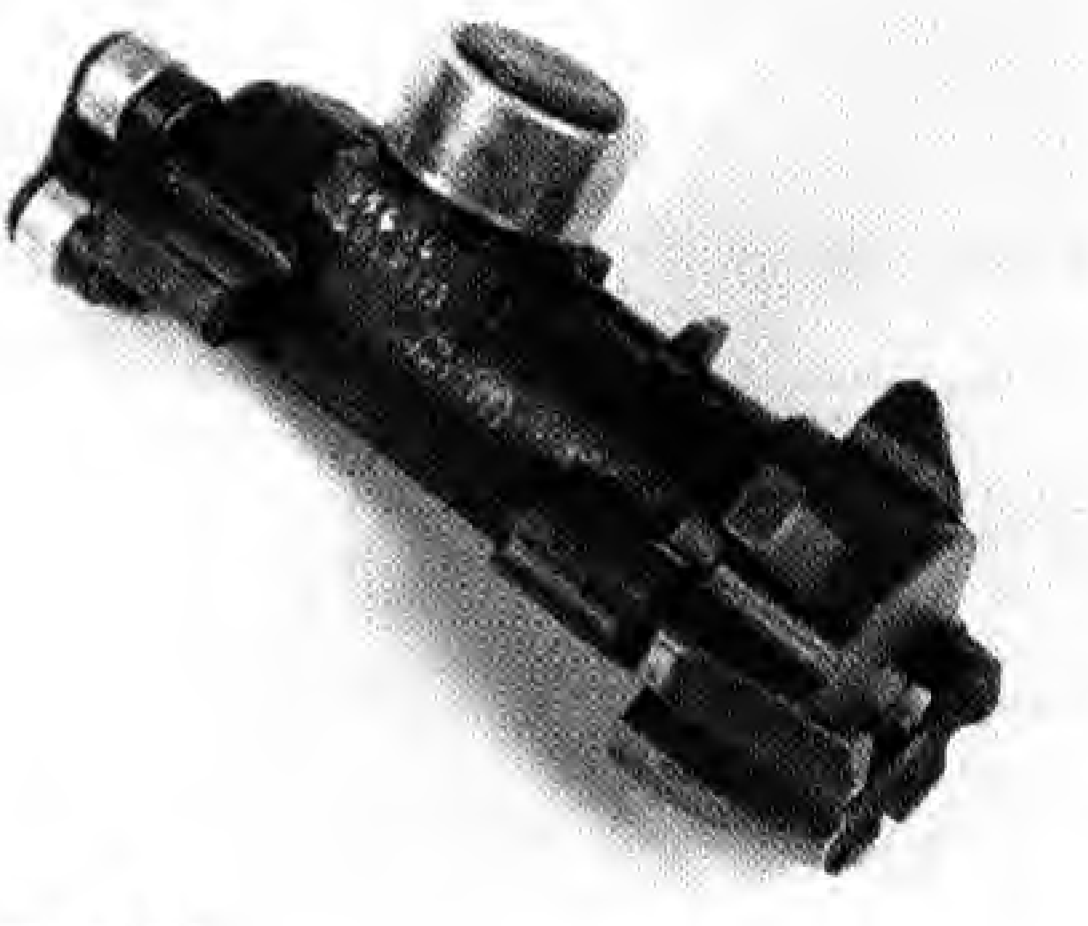
The bolt head is a multi-function gun part. It has seven locking lugs that rotate and line up with mating lugs in the rotor when the bolt is locked, and transfers breech loads to the rotor lugs. It has a fixed extractor lip that engages the cartridge's rim groove at all times while the cartridge is in the gun. The bolt head contains the firing pin and the cocking pin. It has a firing pin hole through which the firing pin tip extends during firing. It has a firing pin - cocking pin shoulder for holding the firing pin back during gun cycling when not firing. It has machined cuts so that it can fit and rotate inside the bolt body during lock and unlock. Its aft end contacts the lock-unlock cam follower and is driven by this follower when pinned together.

The cam follower slides into the rear of the body and the head and is pinned. This pin also transmits torque between the follower and head. Two rollers are pinned to the follower. The rollers ride in the lock-unlock cam in the housing and rotate the head into lock and unlock.

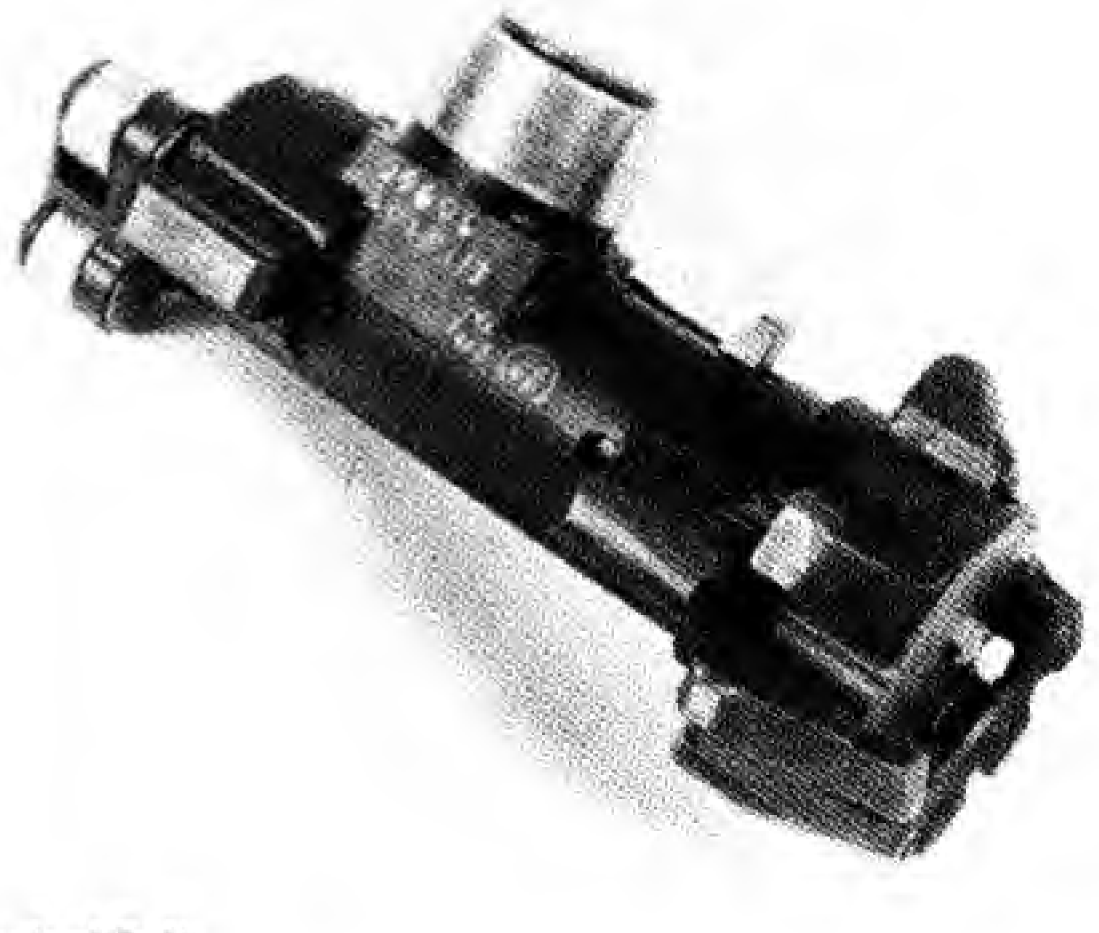
The firing pin and spring ride inside the bolt head rear shaft. The cocking pin is assembled through the

Characteristics

Rate Capability	Dual
High Rate	4200 spm
Low Rate	2100 spm
Number of Barrels	Seven
Barrel Length	86 in.
Overall Length of Gun	115 in.
Ammunition	30mm
Type	HEI, API, TP, and dummy
Weight/Round:	
HEI	1.53 lbs.
API	1.65 lbs.
TP	1.53 lbs.
Dummy	1.53 lbs.
Drum Diameter	34 in.
Power Requirements (Feed System Only):	
Electrical:	
Non Firing	28 vdc @ 0.5 Amps
Firing	28 vdc @ 0.5 Amps
Clearing	28 vdc @ 0.5 Amps
Mechanical:	
Full Rate	27.5 hp
Half Rate	14.0 hp



Unlocked Bolt



Locked Bolt

body and the head shaft into the firing pin where it is pinned from outside the body. During operation the cocking pin is cammed by the safety and cocking cam during ram, and is seared off the shoulder on the cam for firing after the head is locked.

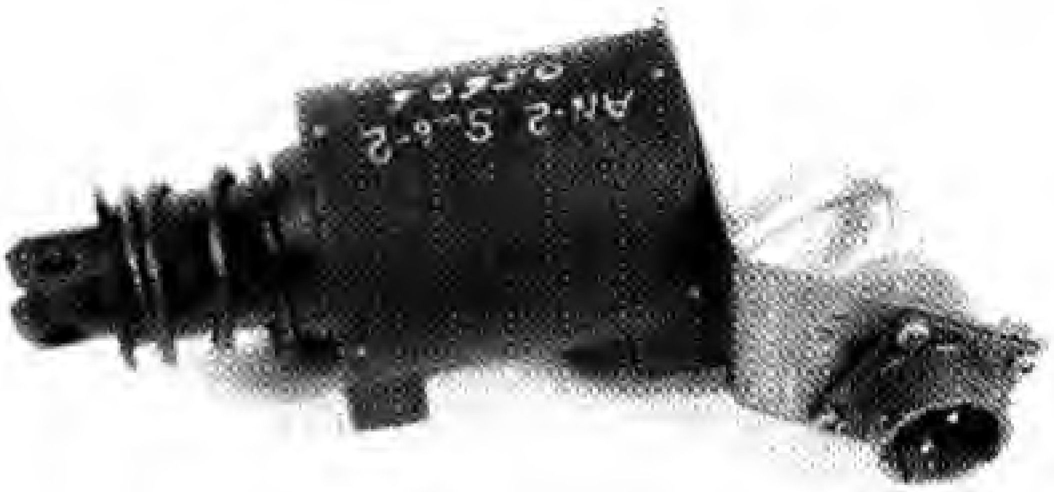
Description of Major Components

The Avenger is a rotary gun. The gun parts that rotate are assembled together and placed inside the gun housing that is fixed and does not rotate.

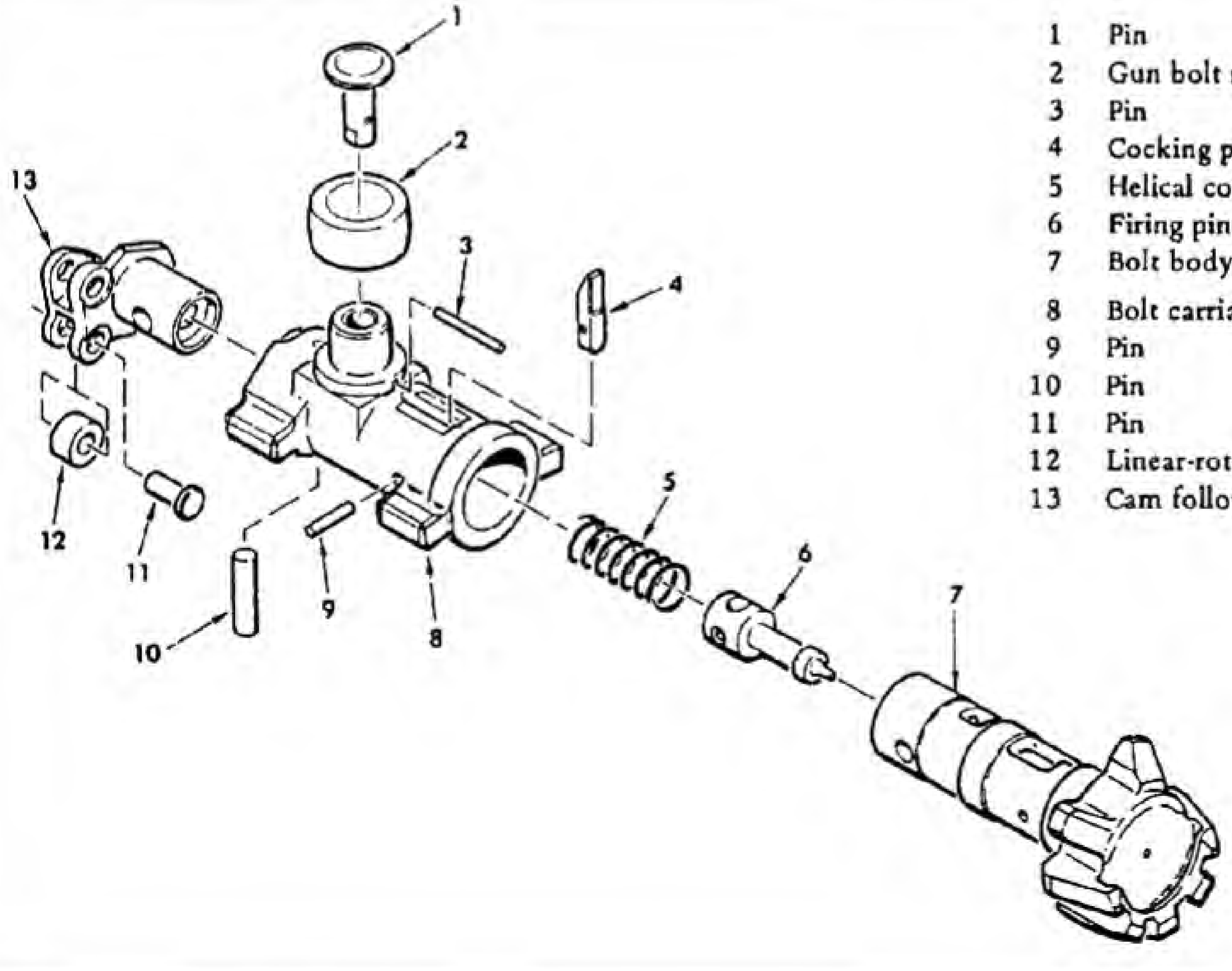
The main rotary part is the rotor, and the rotor holds the seven barrel cluster forming the heaviest subassembly of the gun.

Rotor. The rotor is an assembly of many parts, but it has two major parts. The first is the forward rotor that locates, holds and locks the barrels to it longitudinally. The second is the rear rotor that forms the seven trackways for the gun bolts to traverse upon.

Bolt Assembly

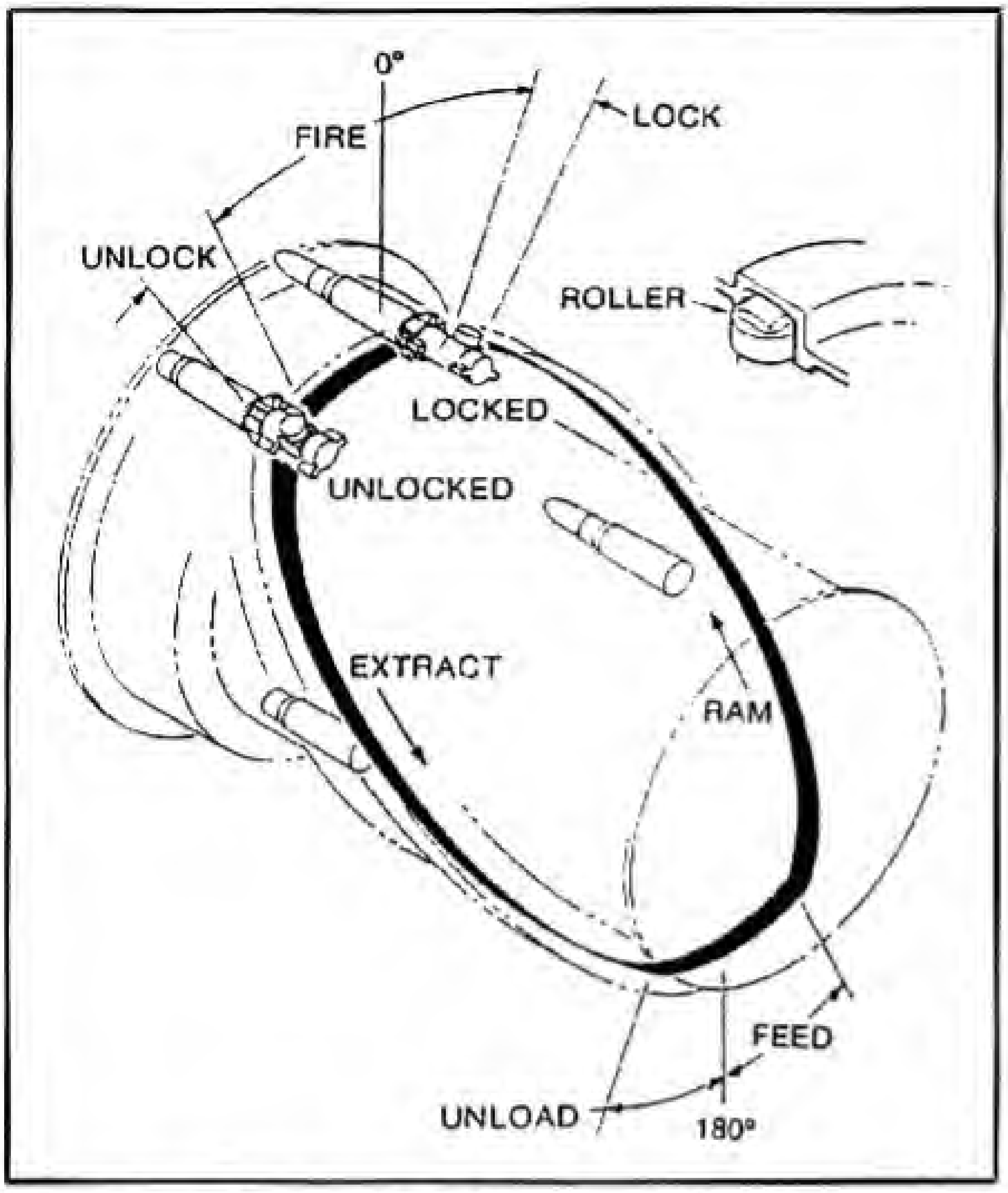


Solenoid Assembly

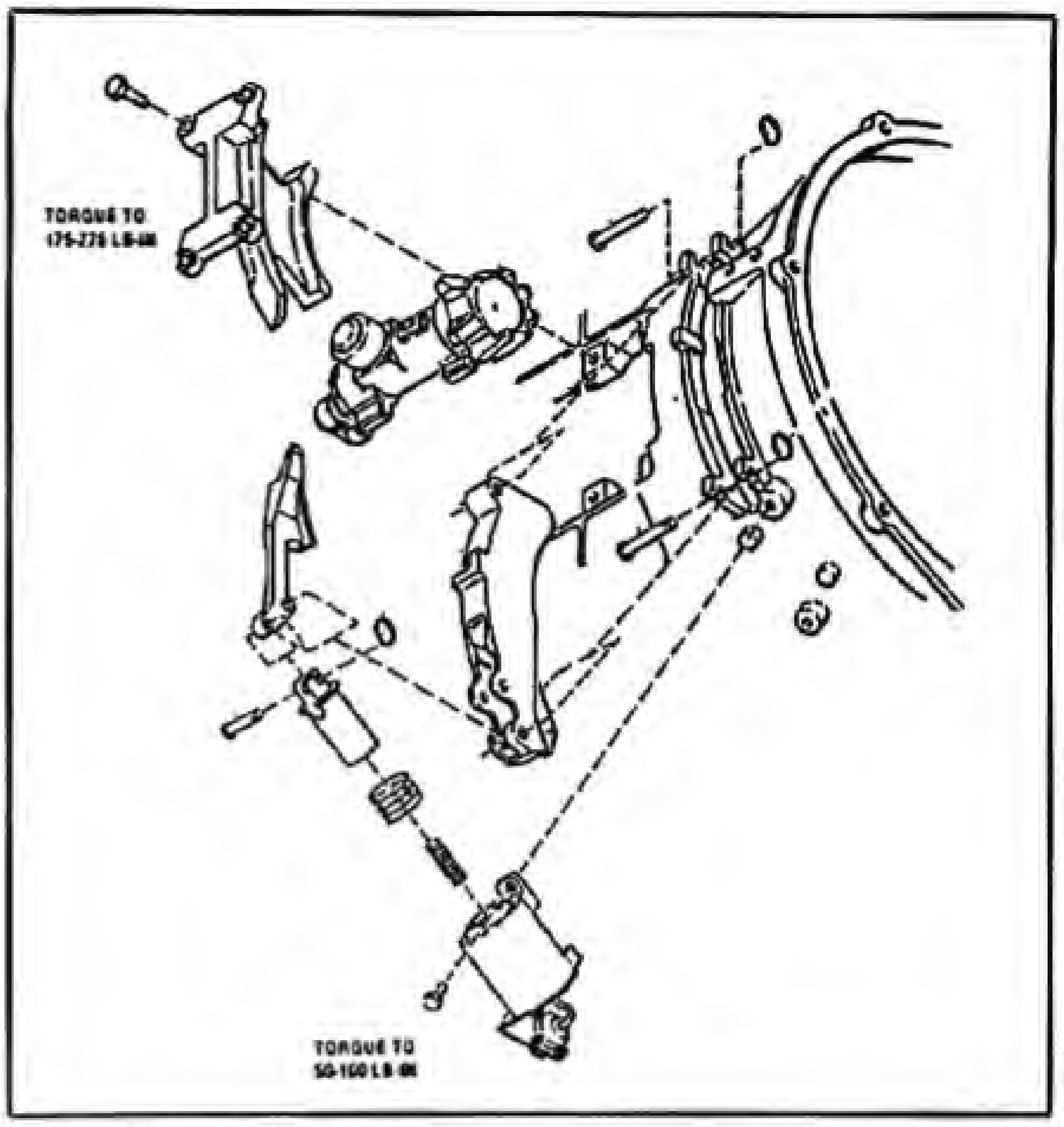


1	Pin
2	Gun bolt roller
3	Pin
4	Cocking pin
5	Helical compression spring
6	Firing pin
7	Bolt body
8	Bolt carriage
9	Pin
10	Pin
11	Pin
12	Linear-rotary motion roller
13	Cam follower

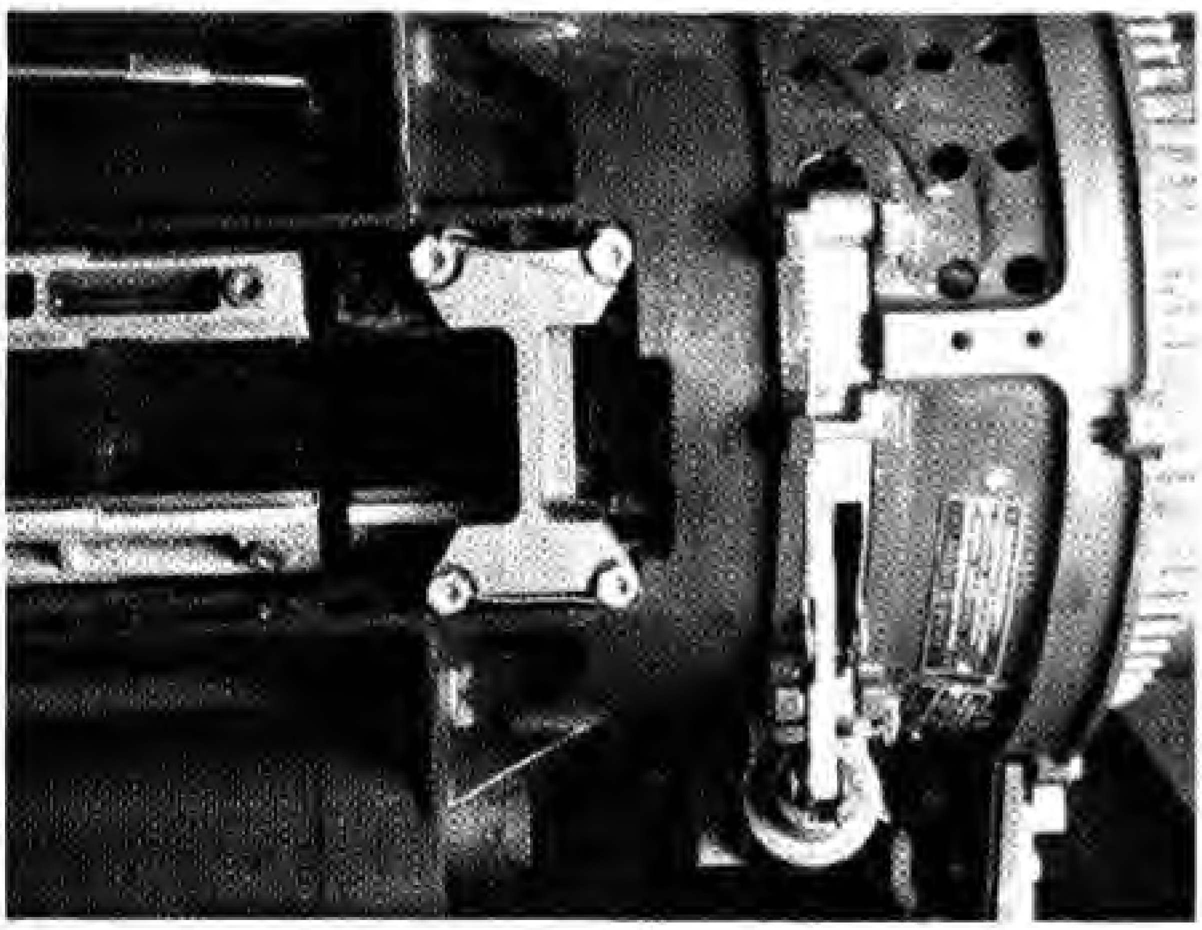
Bolt Assembly (Exploded View)


0°
FIRE
LOCK
UNLOCK
ROLLER
LOCKED
UNLOCKED
EXTRACT
RAM
FEED
UNLOAD
180°

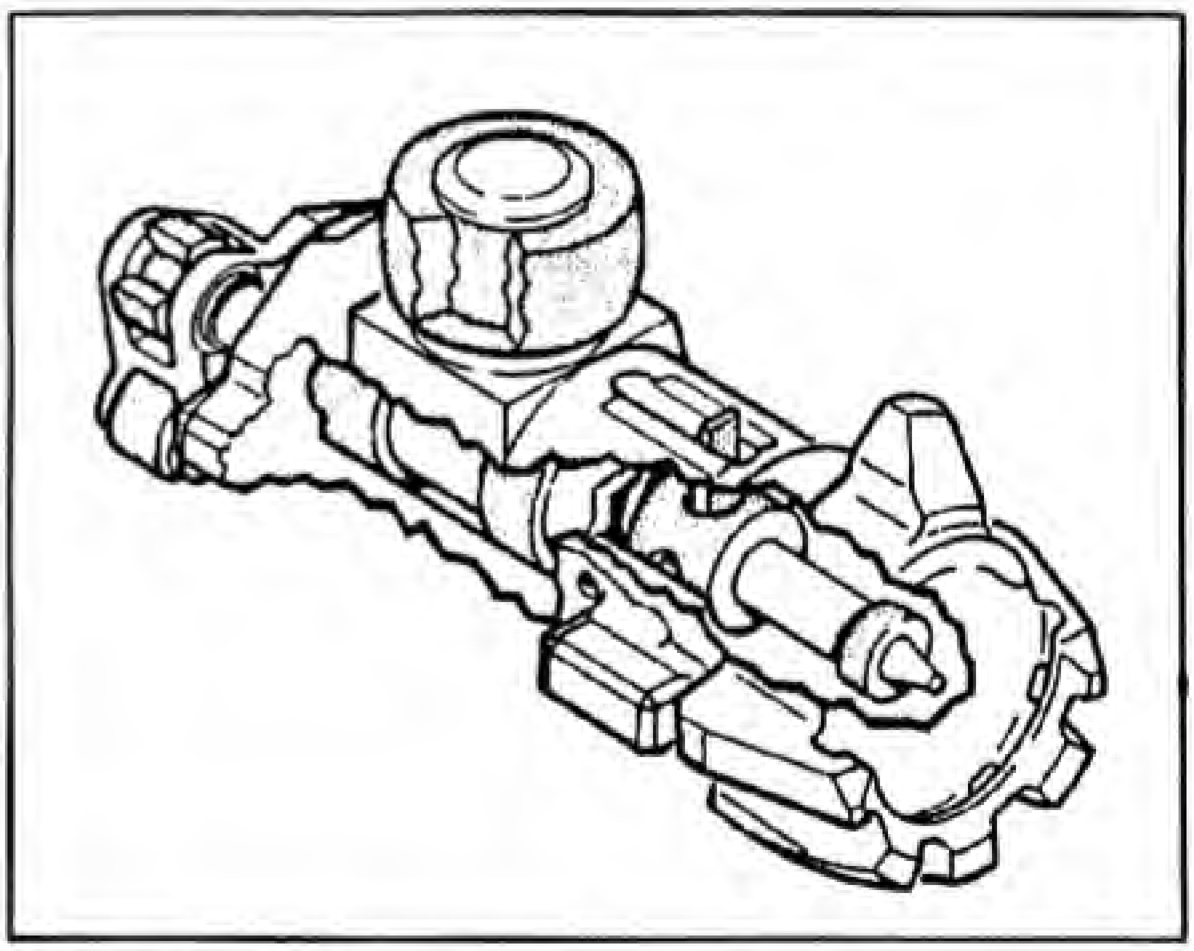
Firing Cycle Showing Bolt Motion


TORQUE TO
175-225 LB-IN
TORQUE TO
50-100 LB-IN

30mm Gun Assembly



Housing



Rotary Bolt Head

The forward rotor and the rear rotor are bolted together and for all practical purposes form a permanent assembly. A major bearing fits over the forward rotor. This bearing transmits breech firing loads to the gun housing. The gun bolt breech locking lugs and the barrel lugs are located almost adjacent to this bearing forming a host force path for containing the breech and for load transmittal to the housing.

This feature relieves the rear rotor from breech loads and allows the rear rotor to be of a lightweight design. As a note of interest, the Vulcan 20mm gun's rear rotor contains the bolt locking areas, and so receives and must transmit the breech loads making it a heavier equivalent part than the Avenger's rear rotor.

A major gun driving gear is machined on the forward rotor. The trackways for the gun bolts are bolted to the rear rotor. The rear most tracks have quick disconnect provisions for installing and removing the gun bolts.

This completes the rotor assembly. It is shipped rearward into the gun housing until the major rotor bearing seats on its mating shoulder on the forward diameter of the gun housing.

The rear of the rotor is only radially supported by a bearing that is assembled between the rotor and the housing. A new bearing retainer and gear is bolted to the rear of the rotor taking out all end play in the bearings. The rotor is now seated and locked inside the housing and is free to rotate.

Barrel Cluster. One at a time, the barrels are inserted into the forward rotor. The three breech locking lugs on the barrel are engaged into mating locking lugs in the rotor by turning the barrel by 180°. These lugs lock the barrel to the rotor longitudinally but not rotationally about the barrel's axis which is taken care of by the center barrel support.

When all seven barrels are assembled to the rotor, the mid-barrel support is slipped over the muzzles and to its mid-barrel location, where it locks all the barrels rotationally to each other forming the first part of the cluster. This mid-barrel support is also used as a gun support with a mating ring on the mounting structure.

The muzzle clamp is placed over all the muzzles. The internal lock is located over the muzzle shoulders, and the front bolt is tightened. This completes the barrel cluster without the use of shims or adjustments.

The cluster and rotor are now free to rotate within the gun housing, but are restrained fore-aft by the rotor bearings.

Gun Housing. The gun housing is the major fixed component of the gun from which all gun cycle functions are referenced. It has a few other uses which include:

1. It contains the gun bolt driving cam which provides mechanical direction to all the gun bolts at the same time so that they are each performing their specific function in relation to each other, and in relation to cartridges entering and cases leaving. This cam includes the bolt locking and unlocking cam.

2. It transmits breech loads from the forward rotor and bearing to the aircraft, through its energy absorbing recoil adapters. There are two adapters which are located at the rear of the housing. They span the 50° firing sector being off-center from the axis of the gun. The recoil adapters also serve as the two rear gun mounts, and together with the mid-barrel support form a three point mounting of the gun to the aircraft or test stand.

3. The gun housing locates and mounts the safing and cocking cam which is bolted at the 50° firing sector location. This cam and its solenoid controls the firing pin—cocking pin during firing and reverse clearing.

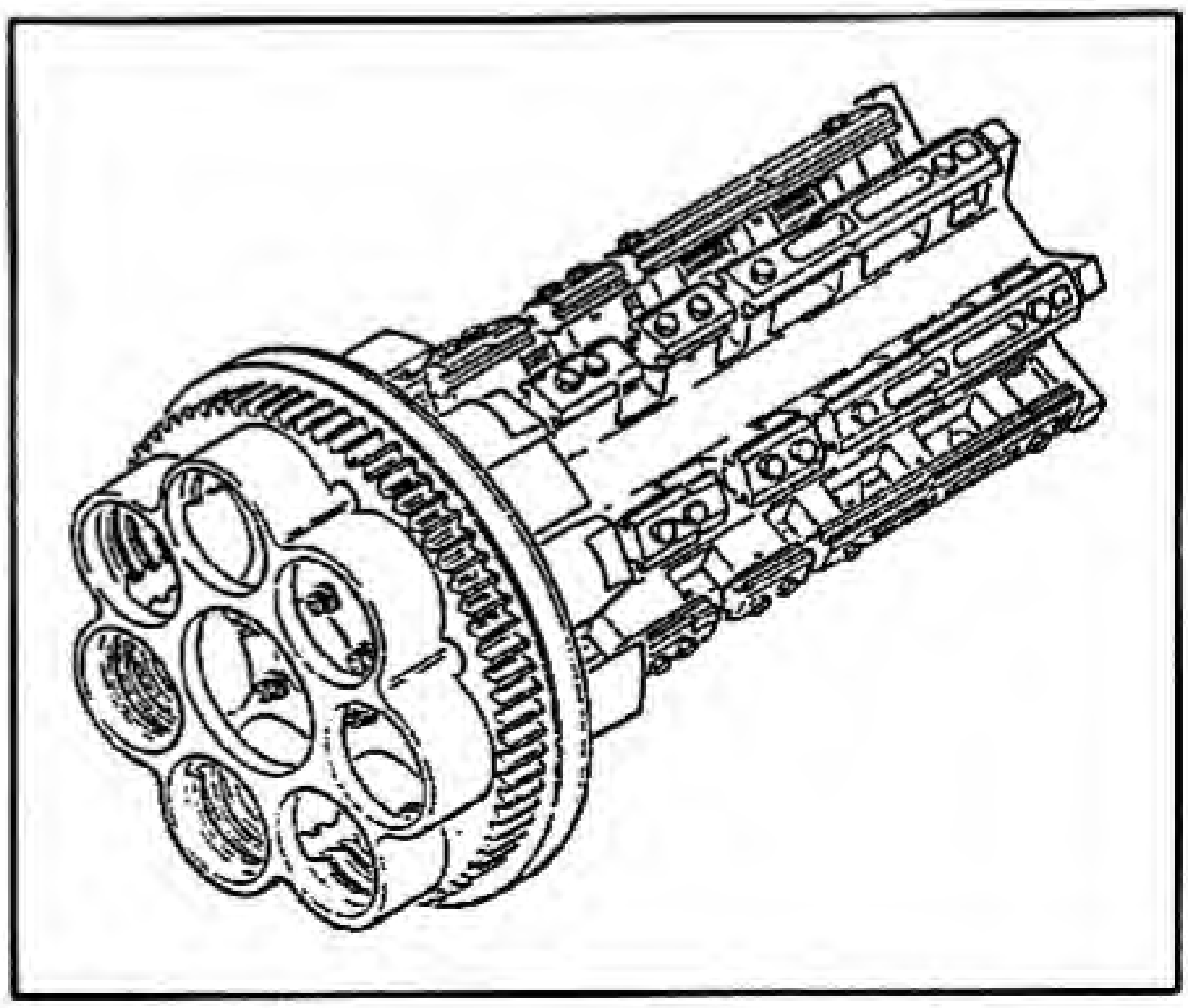
4. There is a gun bolt access in the housing for installing and removing the gun bolts for maintenance.

5. The gun drive shaft and its mating pinion supports and housings are bolted to the housing for driving the rotor assembly at its main forward gear.

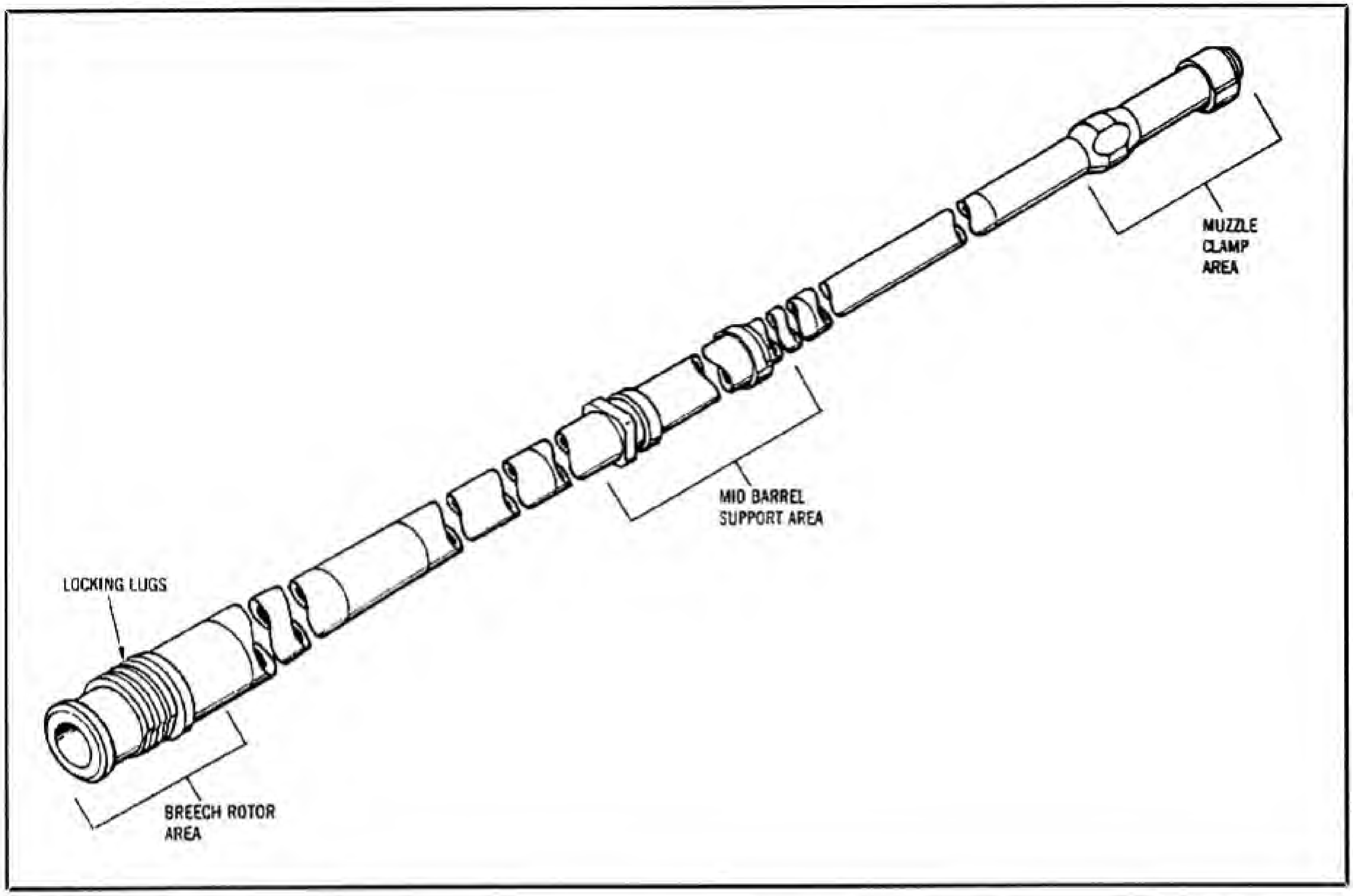
6. The gun housing accurately mounts the transfer unit. This unit is the mechanism that interfaces with the two-way linkless feed systems that deliver new ammo to the gun and removes fired cases, duds and cleared rounds.

On the feed side, this unit takes ammo from the conveyor and delivers it to the gun bolts as in all Vulcan guns. On the eject side, the gun bolts deposit the empty cases into the unload sprocket and hence back into the same conveyor.

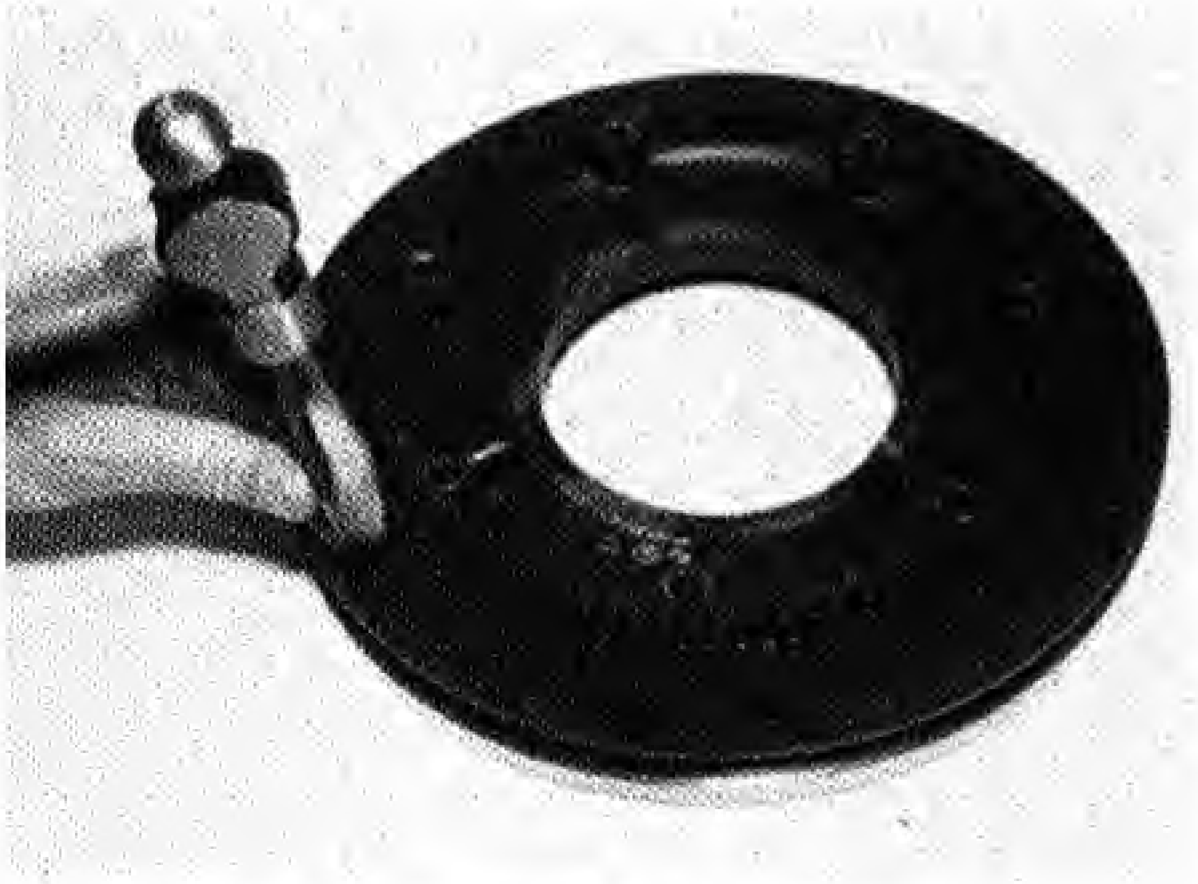
The transfer unit's load and unload sprockets are driven in-time via pinions on their shafts mating with the forward rotor main gear.



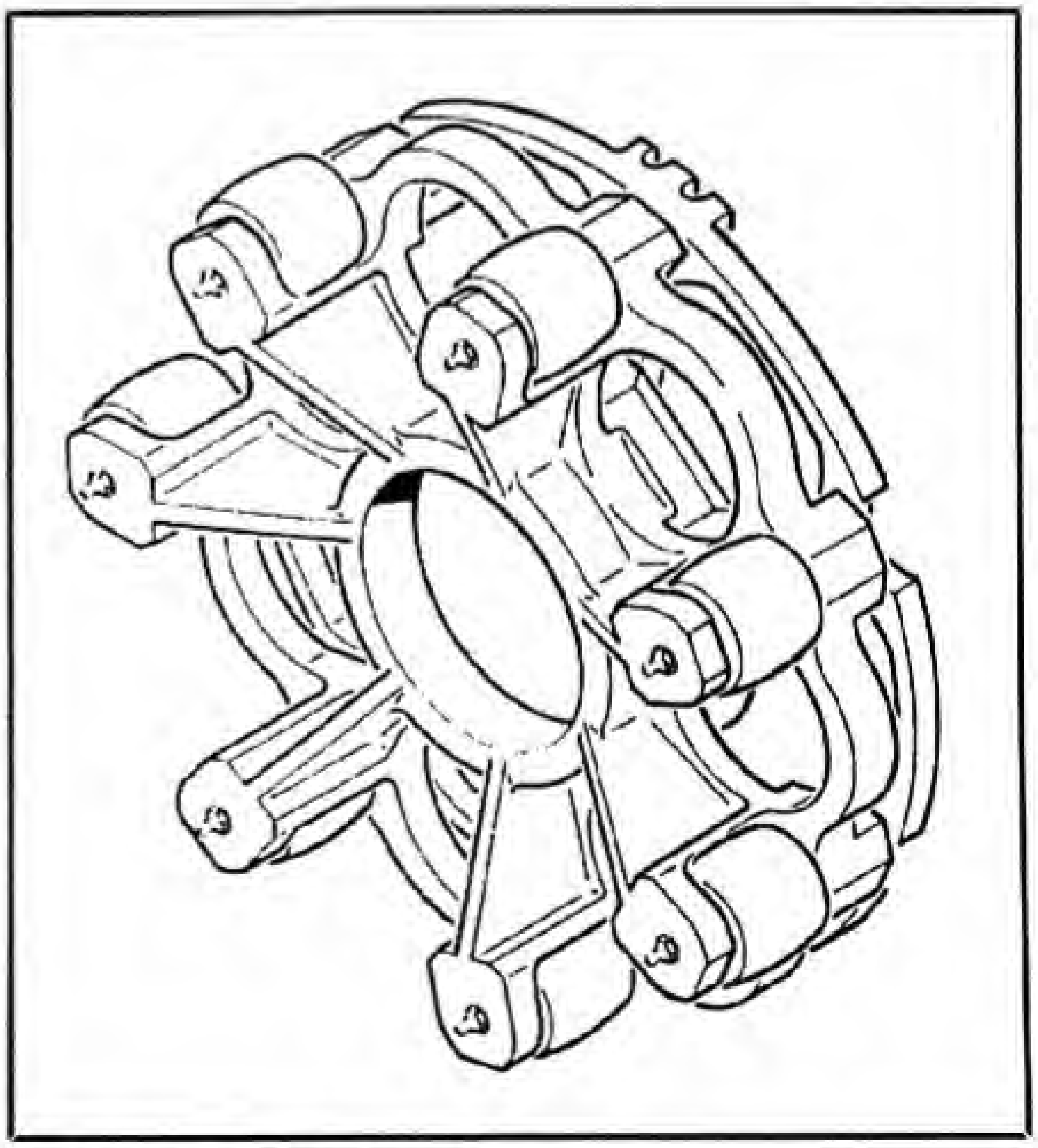
Rotor Assembly


MUZZLE CLAMP AREA
MID BARREL SUPPORT AREA
LOCKING LUGS
BREECH ROTOR AREA

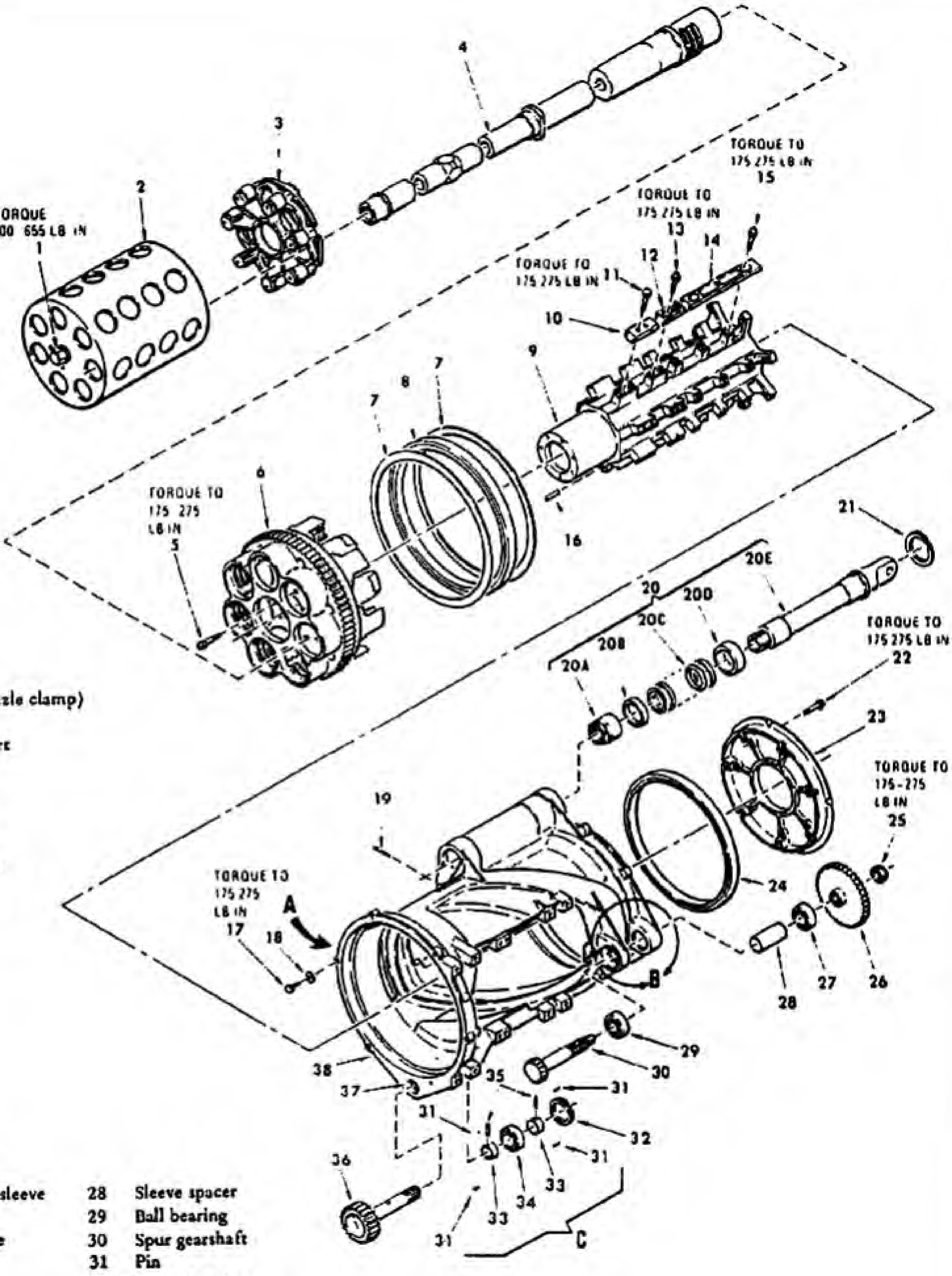
Barrel



Removing Rear Bearing from Rear Spur Gear

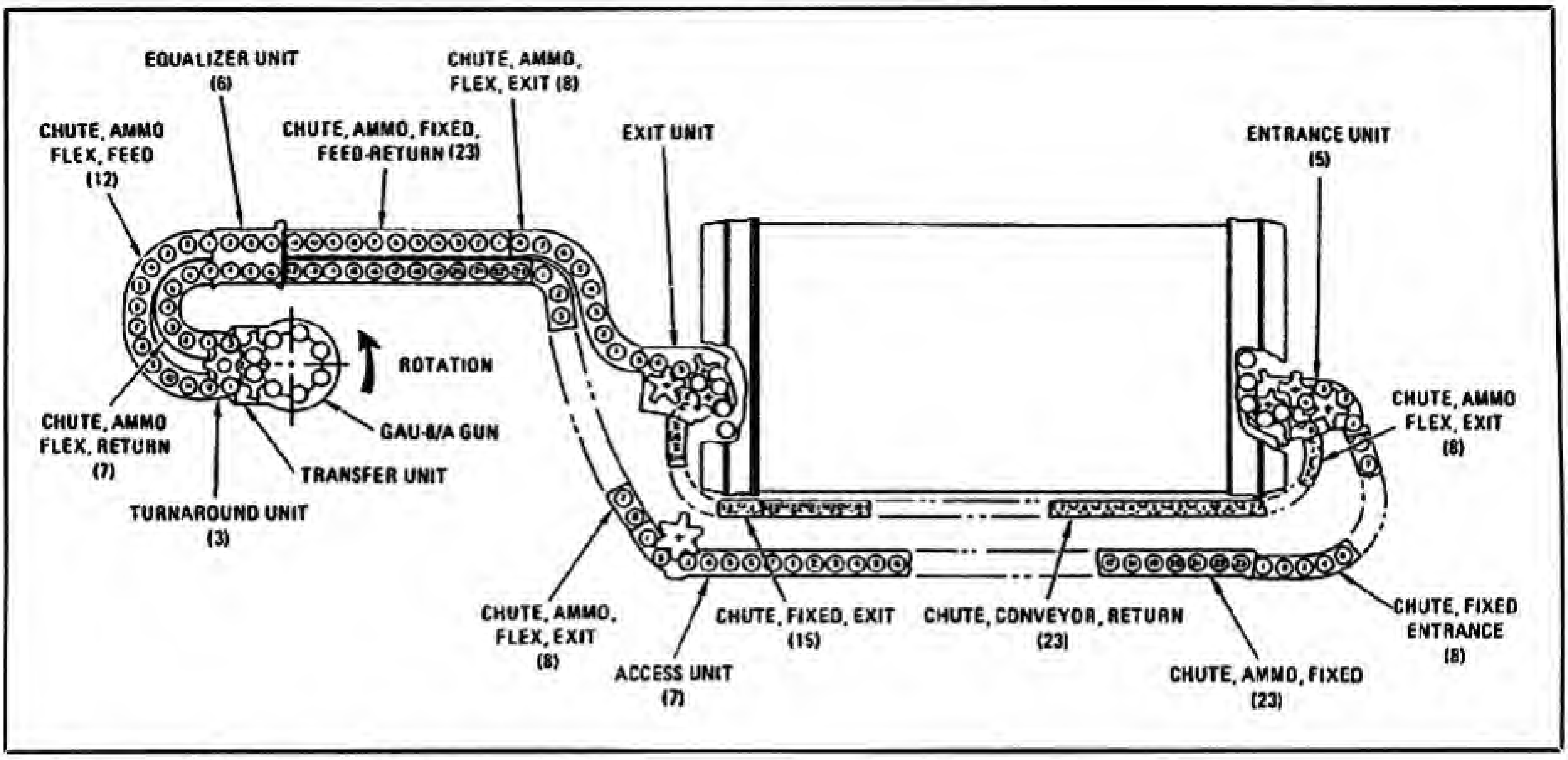


Mid-Barrel Support Assembly


4
3
2
TORQUE 600 655 LB IN
1
TORQUE TO 175 275 LB IN
15
TORQUE TO 175 275 LB IN
13
14
12
TORQUE TO 175 275 LB IN
11
10
9
8
7
7
6
TORQUE TO 175 275 LB IN
5
16
21
20E
20
20D
20C
20B
20A
TORQUE TO 175 275 LB IN
22
23
TORQUE TO 175-275 LB IN
25
19
24
TORQUE TO 175 275 LB IN
17
18
A
B
28
27
26
29
30
38
37
35
31
31
32
31
36
33
34
33
31
C

1	Bolt (Part of muzzle clamp)
2	Muzzle clamp
3	Mid-barrel support
4	Barrel
5	Bolt
6	Forward rotor
7	Bearing shield
8	Forward bearing
9	Mid rotor
10	Forward track
11	Bolt
12	Mid track
13	Bolt
14	Rear track
15	Bolt
16	Pin
17	Bolt
18	Washer
19	Pin
20	Spindle group
20A	Nut
20B	Forward bearing sleeve
20C	Ring spring
20D	Aft bearing sleeve
20E	Spindle
21	Retaining ring
22	Bolt
23	Rear spur gear
24	Rear bearing
25	Nut
26	Spur gear
27	Ball bearing
28	Sleeve spacer
29	Ball bearing
30	Spur gearshaft
31	Pin
32	Retaining ring
33	Retaining sleeve
34	Ball bearing
35	Pin
36	Spur gearshaft
37	Needle bearing
38	Gun housing

30mm Gun Assembly


EQUALIZER UNIT (6)
CHUTE, AMMO, FLEX, EXIT (8)
CHUTE, AMMO FLEX, FEED (12)
CHUTE, AMMO, FIXED, FEED-RETURN (23)
EXIT UNIT
ENTRANCE UNIT (5)
ROTATION
CHUTE, AMMO FLEX, EXIT (8)
CHUTE, AMMO FLEX, RETURN (7)
GAU-8/A GUN
TRANSFER UNIT
TURNAROUND UNIT (3)
CHUTE, AMMO, FLEX, EXIT (8)
ACCESS UNIT (7)
CHUTE, FIXED, EXIT (15)
CHUTE, CONVEYOR, RETURN (23)
CHUTE, AMMO, FIXED (23)
CHUTE, FIXED ENTRANCE (8)

Distribution of Conveyor Elements

of fired cases. To do this the safety and cocking cam on the gun is closed to cam the cocking pin across the sear that is used for firing.

Hydraulic Drive for the Avenger Gun and Linkless Feed System

The hydraulic drive system provides power for dual rate operation of the Avenger GAU-8/A 30mm gun and the Linkless Feed System. The high rate is 4200 spm and the low rate is 2100 spm. The drive can also be operated manually at low rates of up to 1500 rounds per minute to load, clear or cycle the system for maintenance.

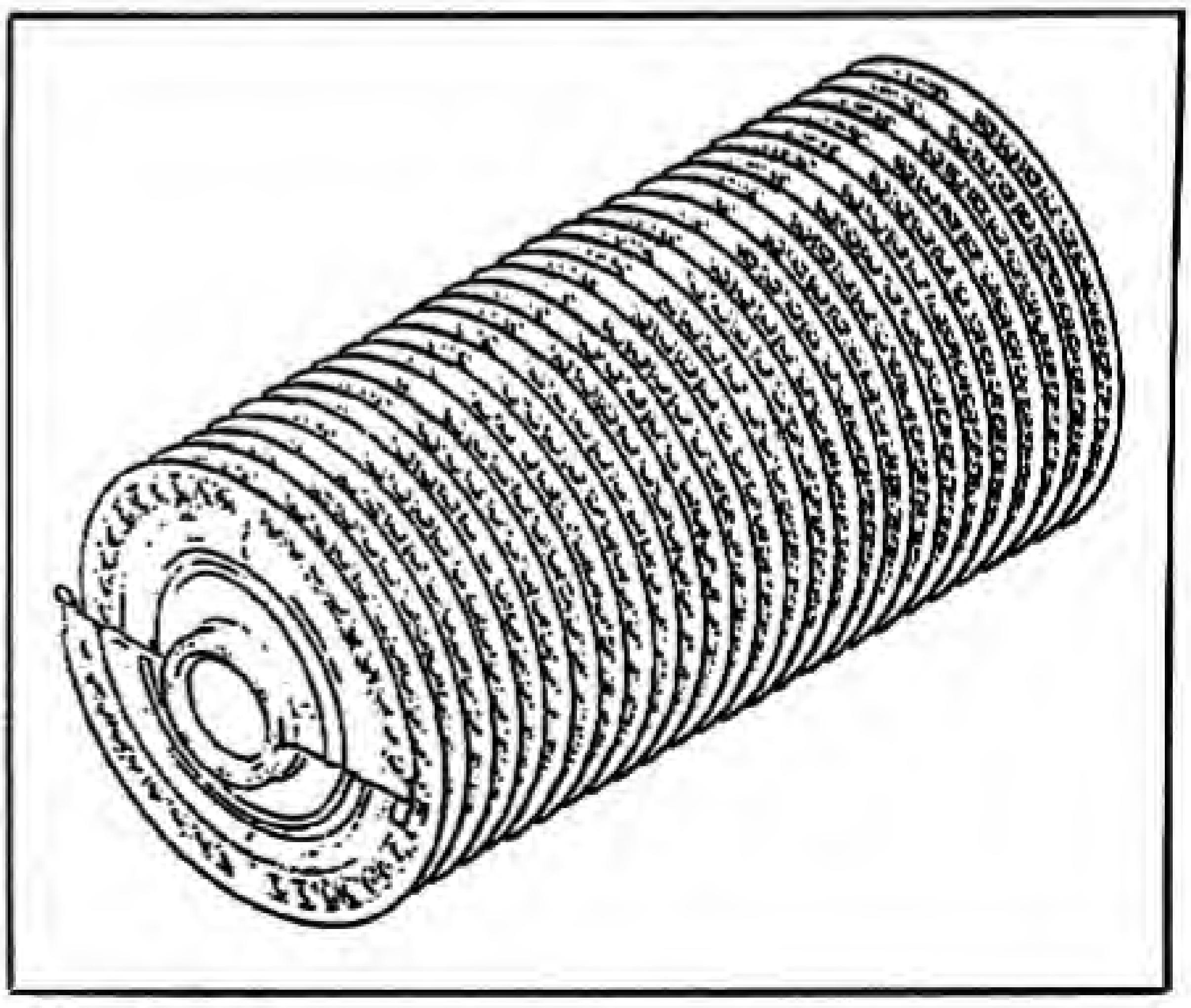
The major components of the drive are two hydraulic drive motors, two flow control valves, a drive gear box, the gun universal joint drive shaft, and the storage drum universal joint drive shaft.

The two hydraulic drive motors are identical to each other, and each contains its own control valve. The control valves uses solenoid-operated pilot valves to actuate the motor control spool which in turn regulates flow at both the inlet and outlet of the motor.

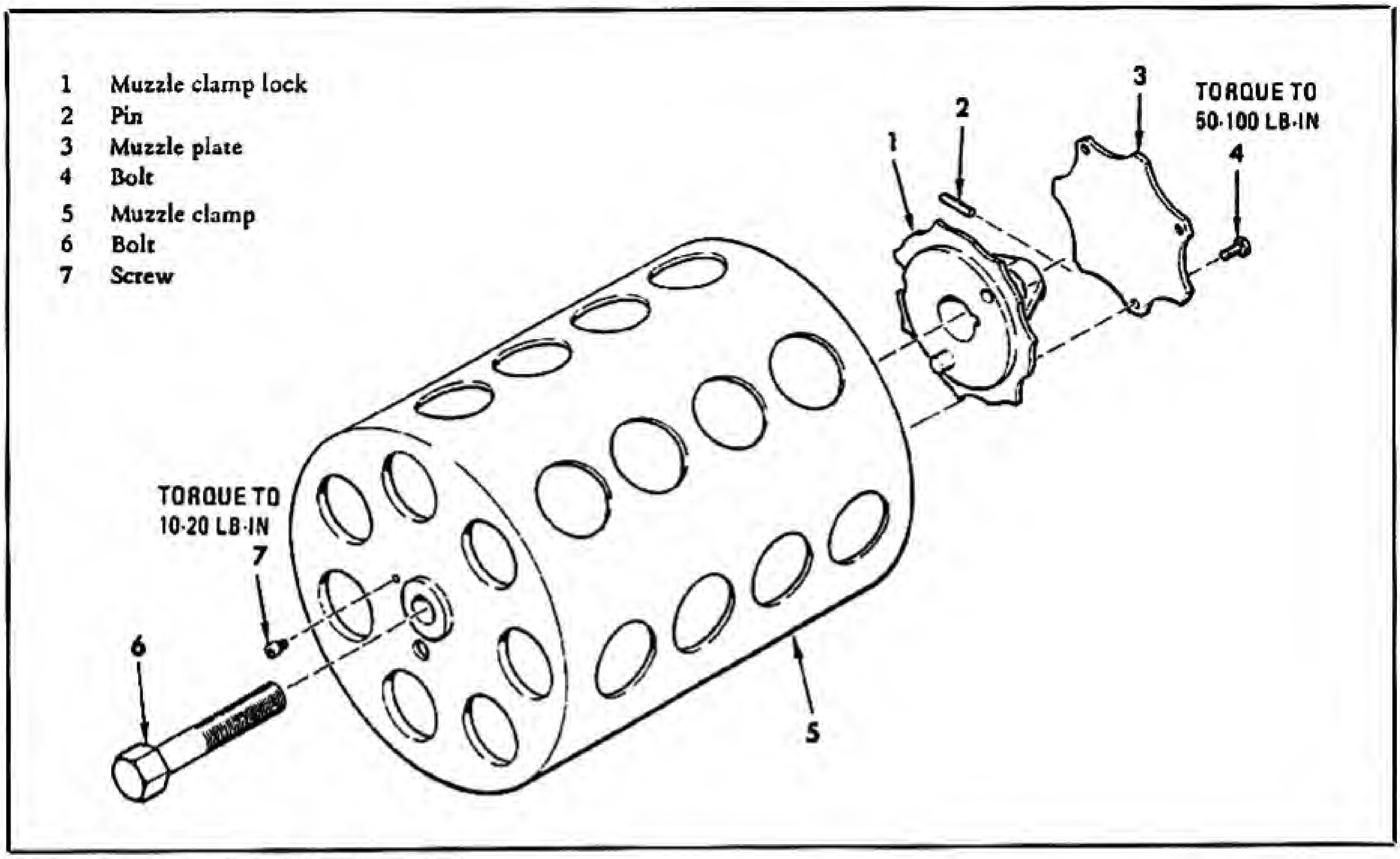
The power train provides dual rate. At full rate, both hydraulic drive motors are operative and supply torque through the gear box to the gun and the drum. At half-rate only one motor is operative providing torque through the 2:1 reduction differential in the gearbox.

Both drive motors are used to decelerate the gun system at the end of each burst after a full or one-half rate burst and, to reverse clear the gun by driving the complete system in reverse.

The Electrical Control Unit (ECU) operates the drive by supplying signals, when the ECU is activated by input command signals from the aircraft's pilot. When a full rate signal is received, the ECU energizes the forward solenoid of both hydraulic motors, and a burst of 4200 spm begins.



Inner Drum



Muzzle Clamp (Exploded View)

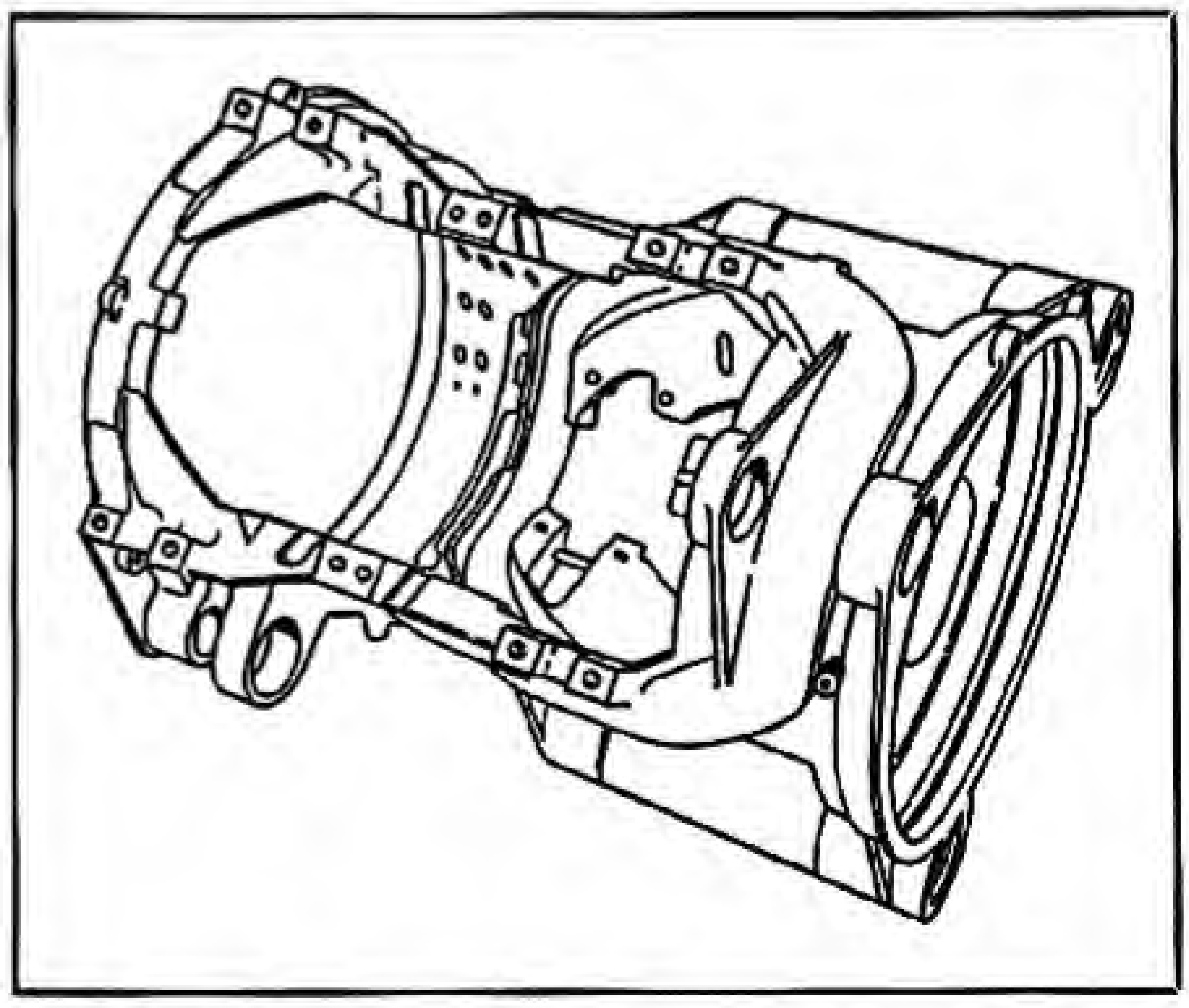
Avenger's Linkless Feed System

A classic linkless feed system was designed and built for the 30mm Avenger GAU-8/A gun. This new system was first designed and had its origin with the Vulcan M61A1 20mm gun program during the second half of the 1950's. The first linkless feed system went operational on the 20mm F105D Fighter aircraft in 1960. The first 30mm linkless feed system was built 10 years later.

For the most part, the largest difference between the 20mm and 30mm systems is size. The Avenger's 30mm system is twice as large. Its drum is 71 inches in diameter and 147 inches long, and the system contains 1350 rounds of 30mm ammunition. Also, considerable weight savings were achieved by design and fabrication of the drum's exit end cover. Beyond the state-of-the-art precision steel casting techniques were developed for this thin wall, highly stressed steel casting.

The storage drum is very much like the Vulcan 20mm drum. It has an outer drum with longitudinal slats on its inside diameter. The outer drum is fixed. The inner drum rotates and has a double helix on its outside diameter. It does not move axially in relation to the outer drum.

Ammunition is stored radially inside the outer drum with the cartridge butts riding in the slats and the projectiles riding in the helixes. As the inner drum helixes turn, all the ammunition is forced from



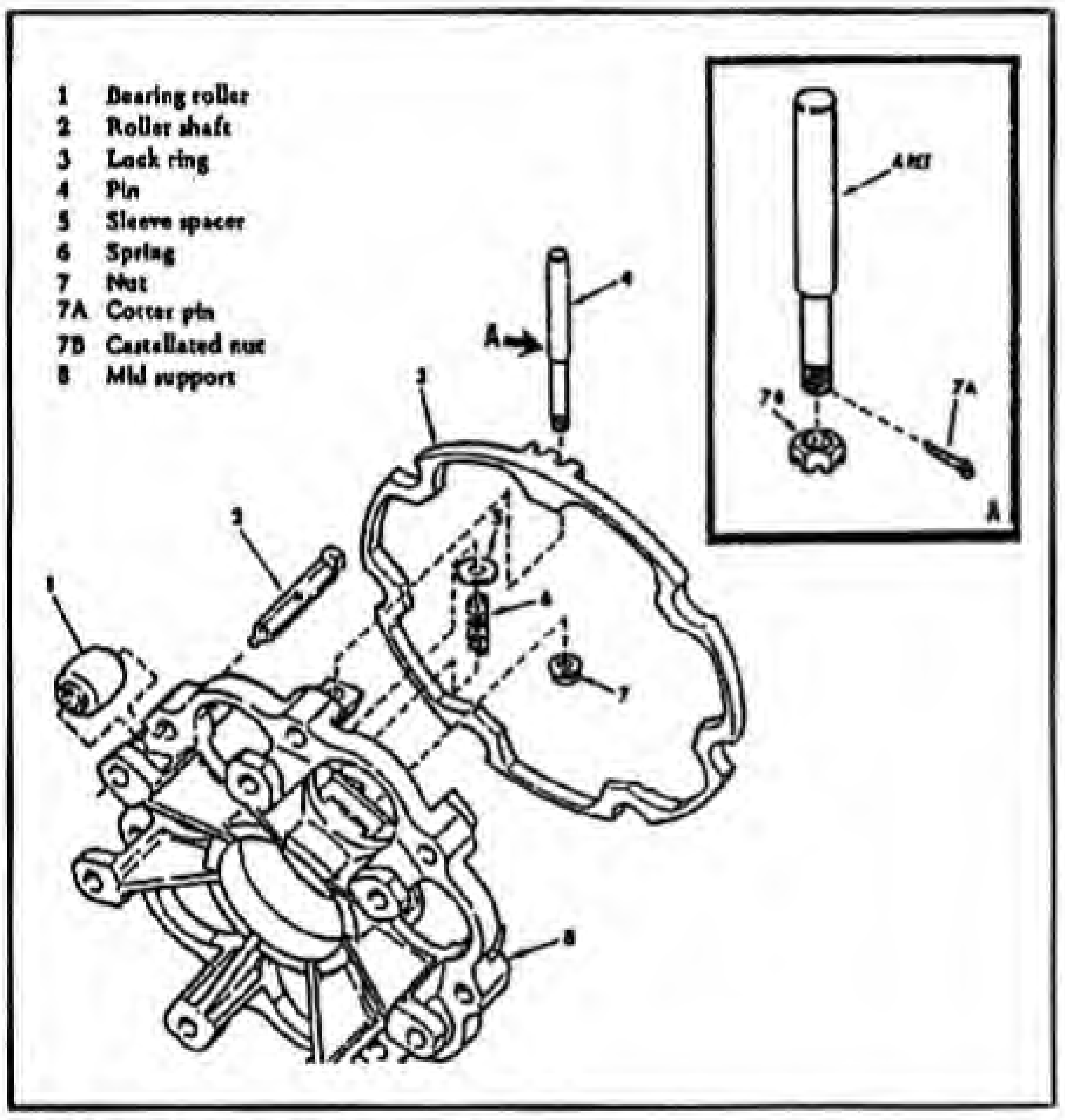
Gun Housing

the back end (called the entrance end) to the front end (called the exit end).

At the exit end, the two terminations of the helixes continuously force two rounds off the forward ends of the slats as the helix ends pass each slat rotationally.

A sprocket is located at the end of each helix, and they travel rotationally with the helixes 180° apart so that they capture each cartridge as it leaves the end of its slat.

The sprockets, in turn, rotate on their own axis', moving the ammo forward and camming them into the retainer partitions. The retainer partition is a ring of radial short spokes of very special shape. The ring of retainers rotate at twice the rotational speed of the helixes. Each spoke (retainer) takes one round in turn from the sprockets. The retainers rotate with the ammo and then deliver each round to a fixed location on the exit end cover which the retainers rotate.



Linkless Feed (Exploded View)

At the exit end cover is a scoop and a sprocket that takes the rounds out of the retainers, making the rounds available to enter conveyor elements one at a time for transport to the gun.

The Avenger's linkless feed system is double-ended. This means that as each round of ammo is taken from the exit, exactly one round is put back in at the other end of the drum called the entrance end. The drum is 100% full of ammo at all times.

The mechanism that removes each round from the exit end of the drum and places it into the conveyor is called the exit unit. At the other end of the drum is the entrance unit.

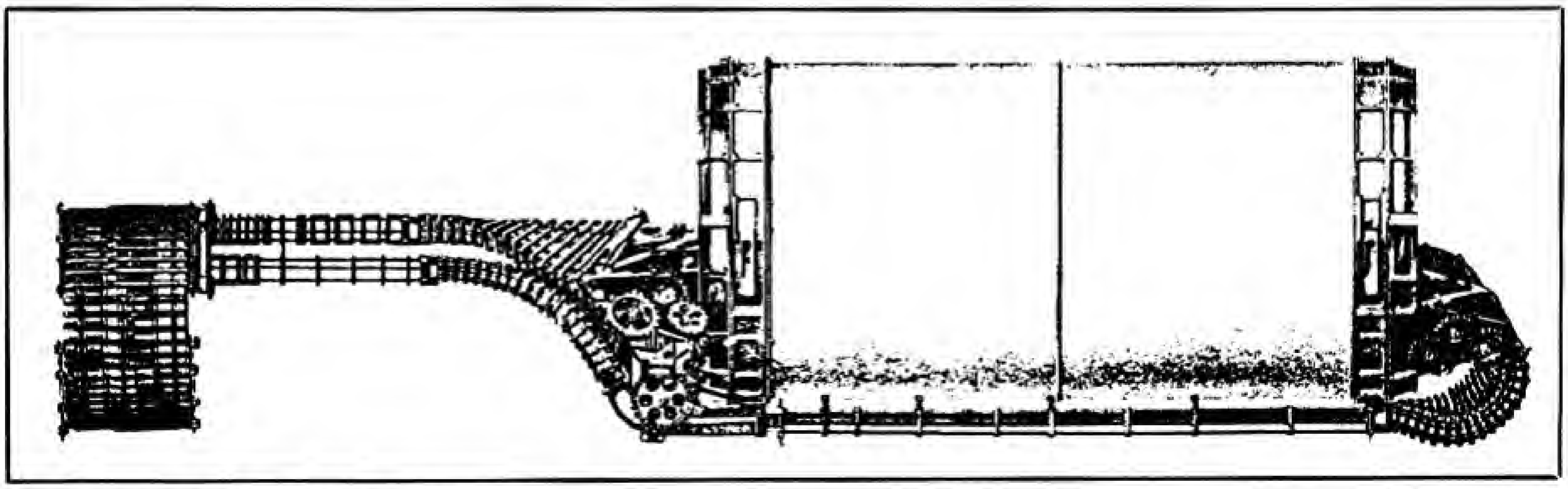
On the gun is the transfer unit. It takes ammo from the conveyor and gives it to the gun bolt for firing. After firing the gun bolt gives the empty case or unfired round back to the conveyor. The conveyor then delivers the case to the entrance unit where it is inserted into the drum.

The conveyor leaves the entrance unit as an empty conveyor and proceeds to the exit unit while it picks up another round again for transport to the gun.

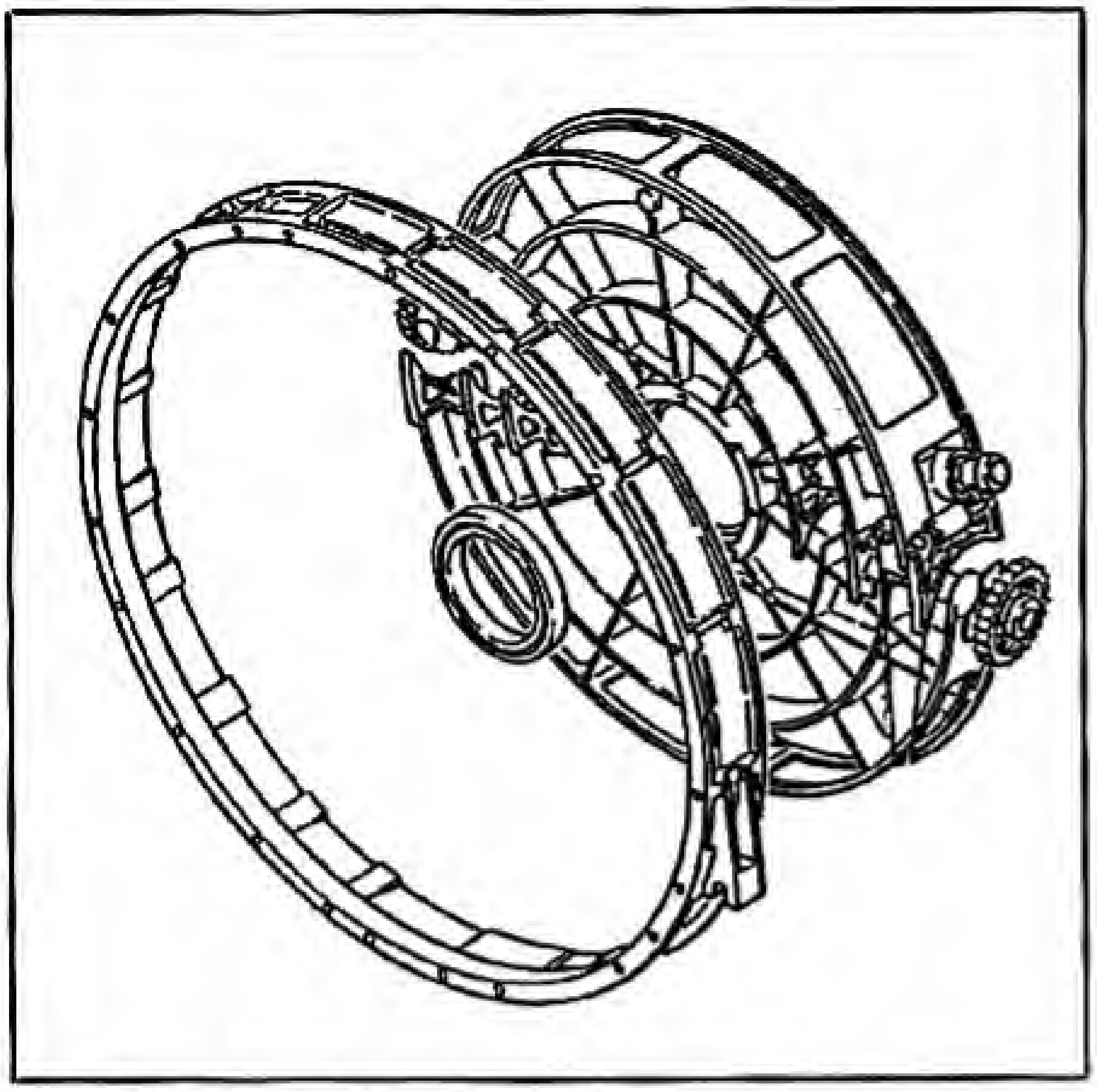
The complete feed system operates with new rounds of ammo, spent cases or unfired rounds in any mix; and, must be 100% full at all times to operate.

The Avenger gun and the Linkless Feed System can operate forward as it does when the gun is firing, and it can operate in reverse as it does when clearing and when loading.

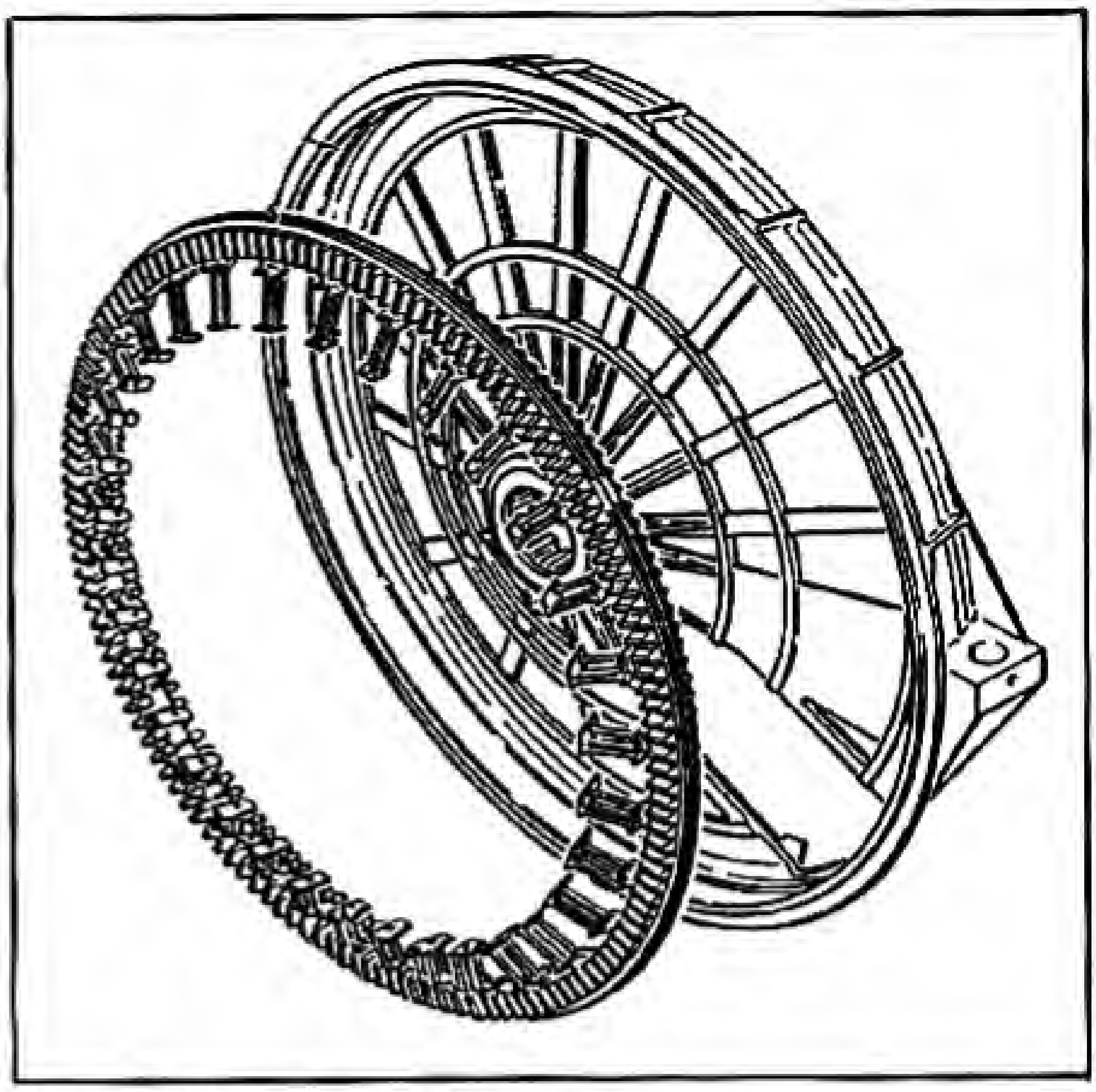
Gun clearing takes place after each burst by automatically backing up the system until the gun is full



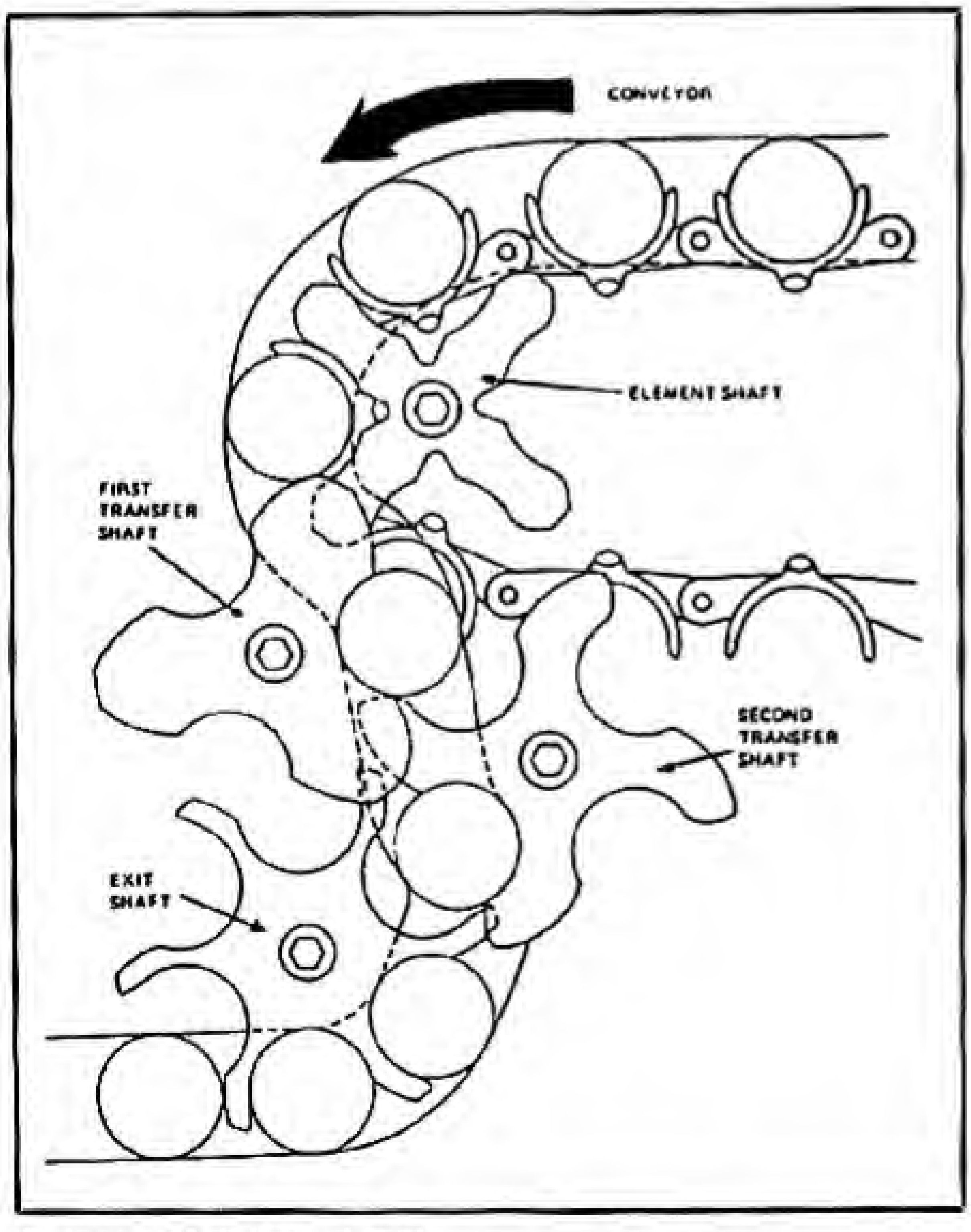
Ammunition Feed and Storage Subsystem



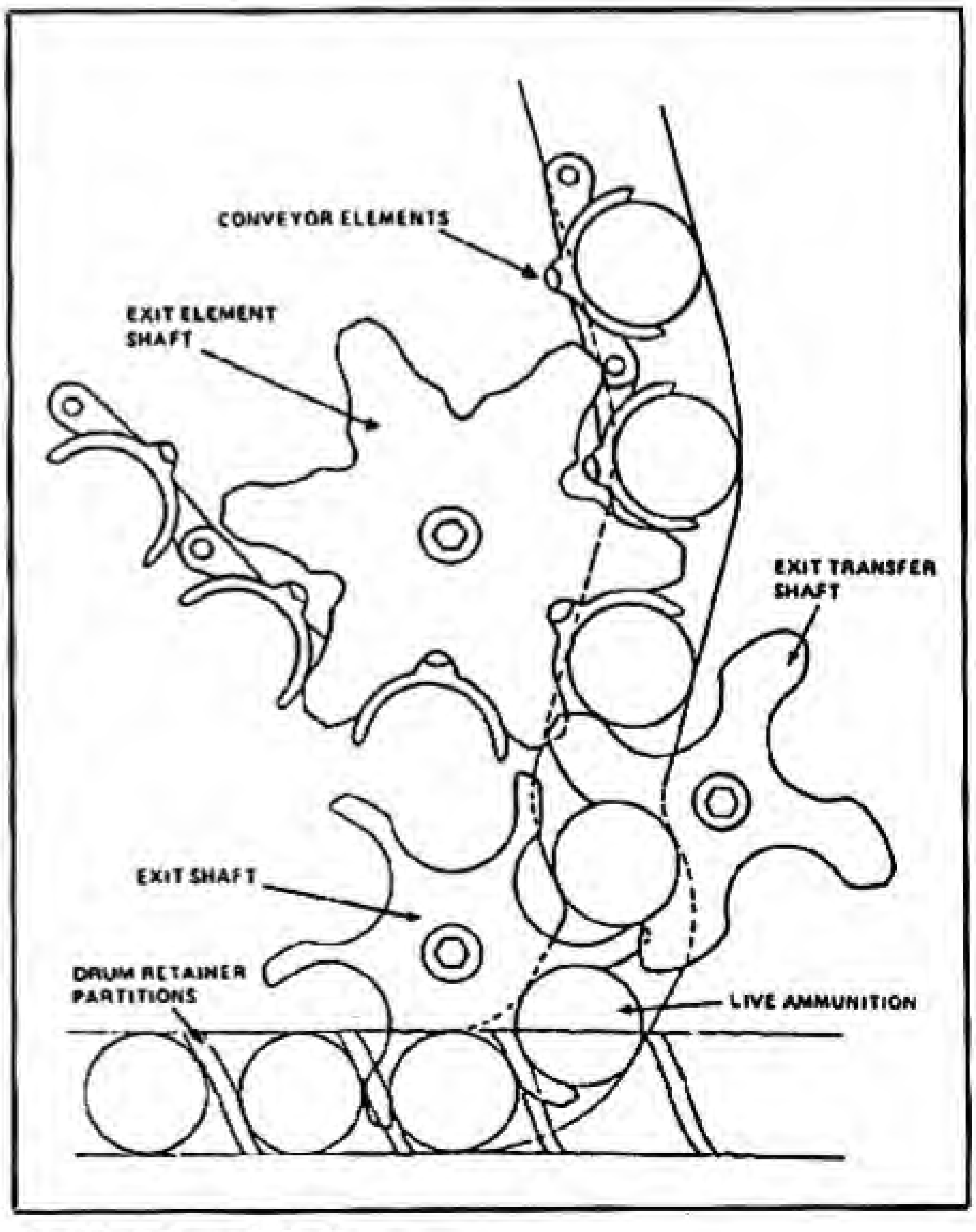
Scoop Disc Assembly



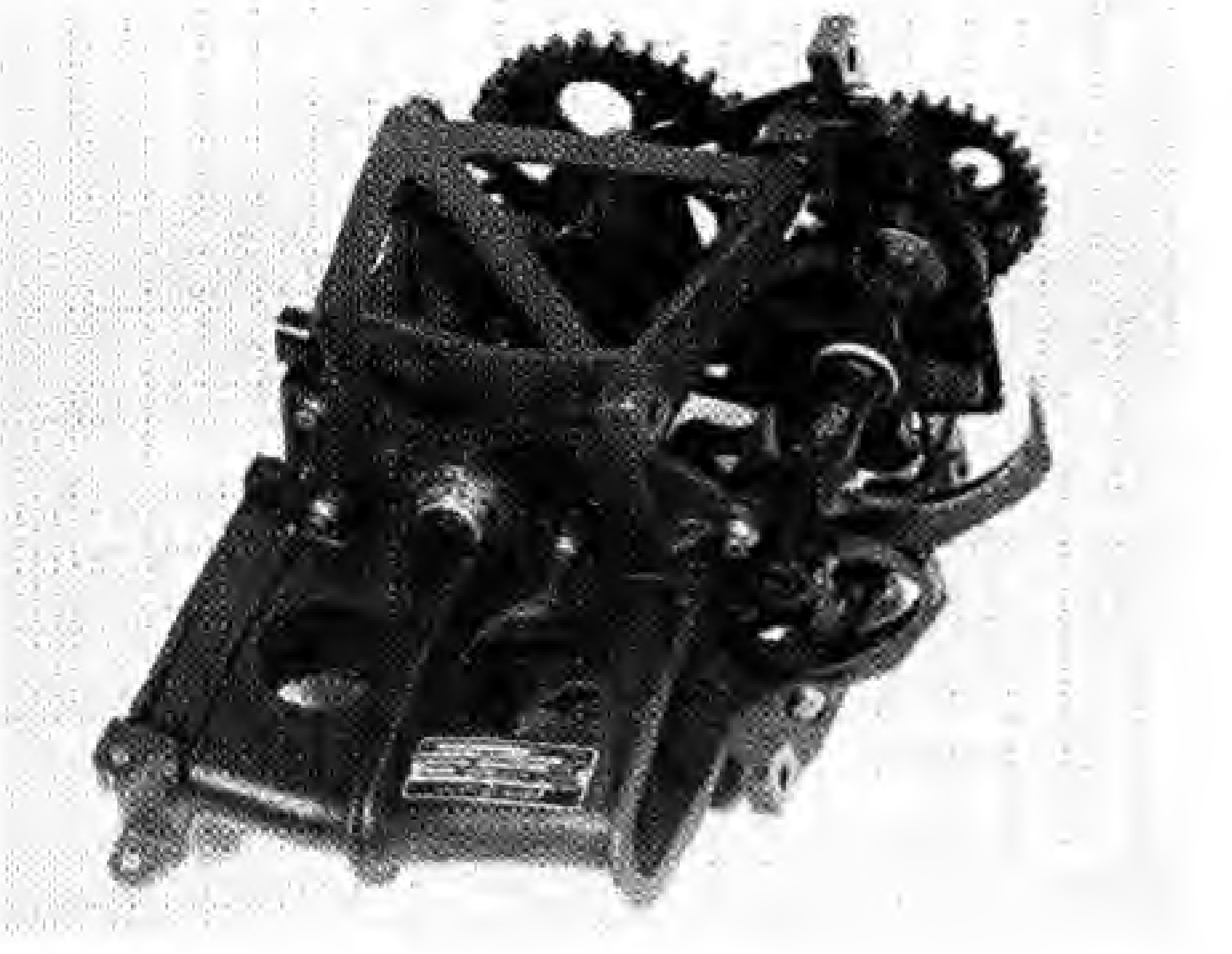
Entrance Cover Assembly


CONVEYOR
ELEMENT SHAFT
FIRST TRANSFER SHAFT
SECOND TRANSFER SHAFT
EXIT SHAFT

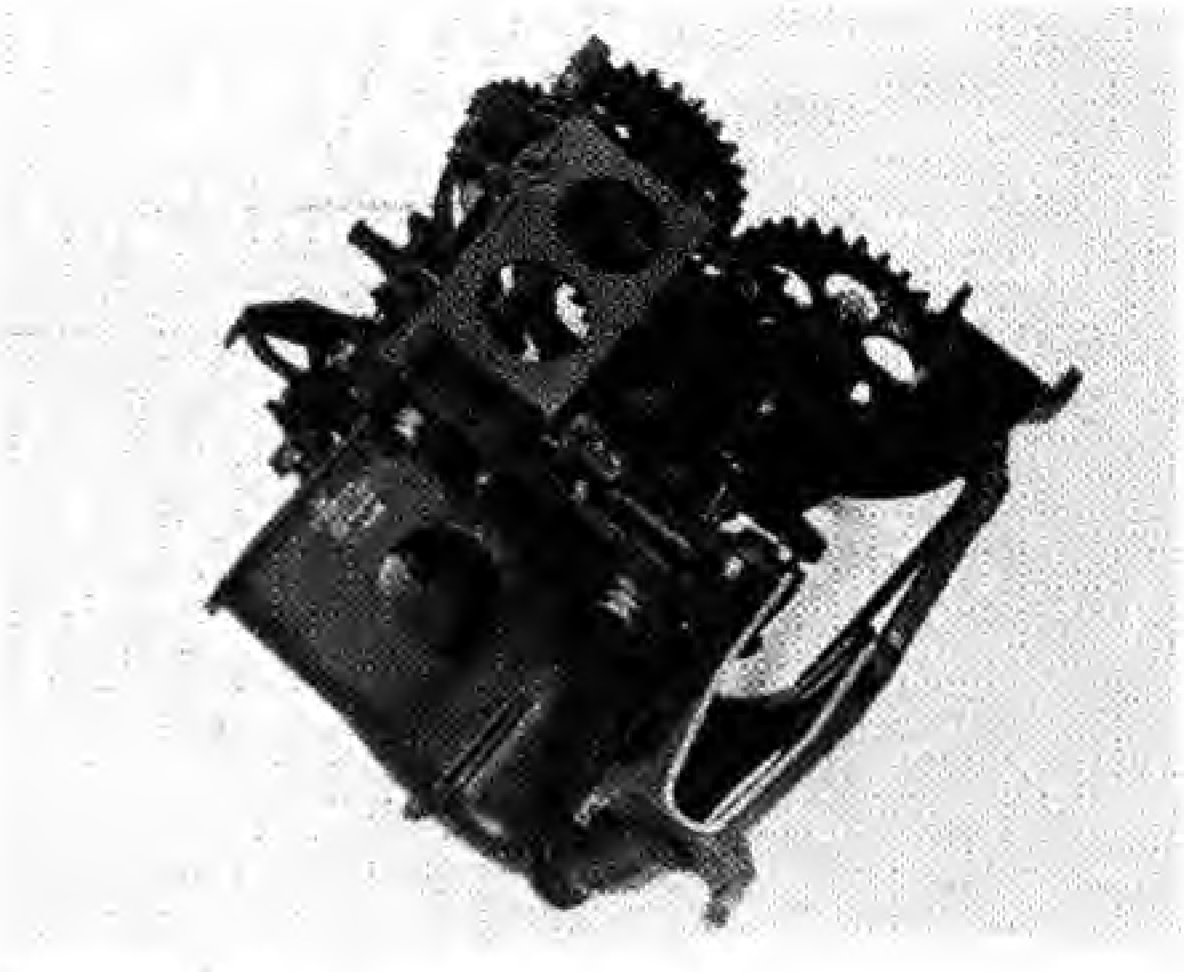
Entrance Unit Round Path


CONVEYOR ELEMENTS
EXIT ELEMENT SHAFT
EXIT TRANSFER SHAFT
EXIT SHAFT
DRUM RETAINER PARTITIONS
LIVE AMMUNITION

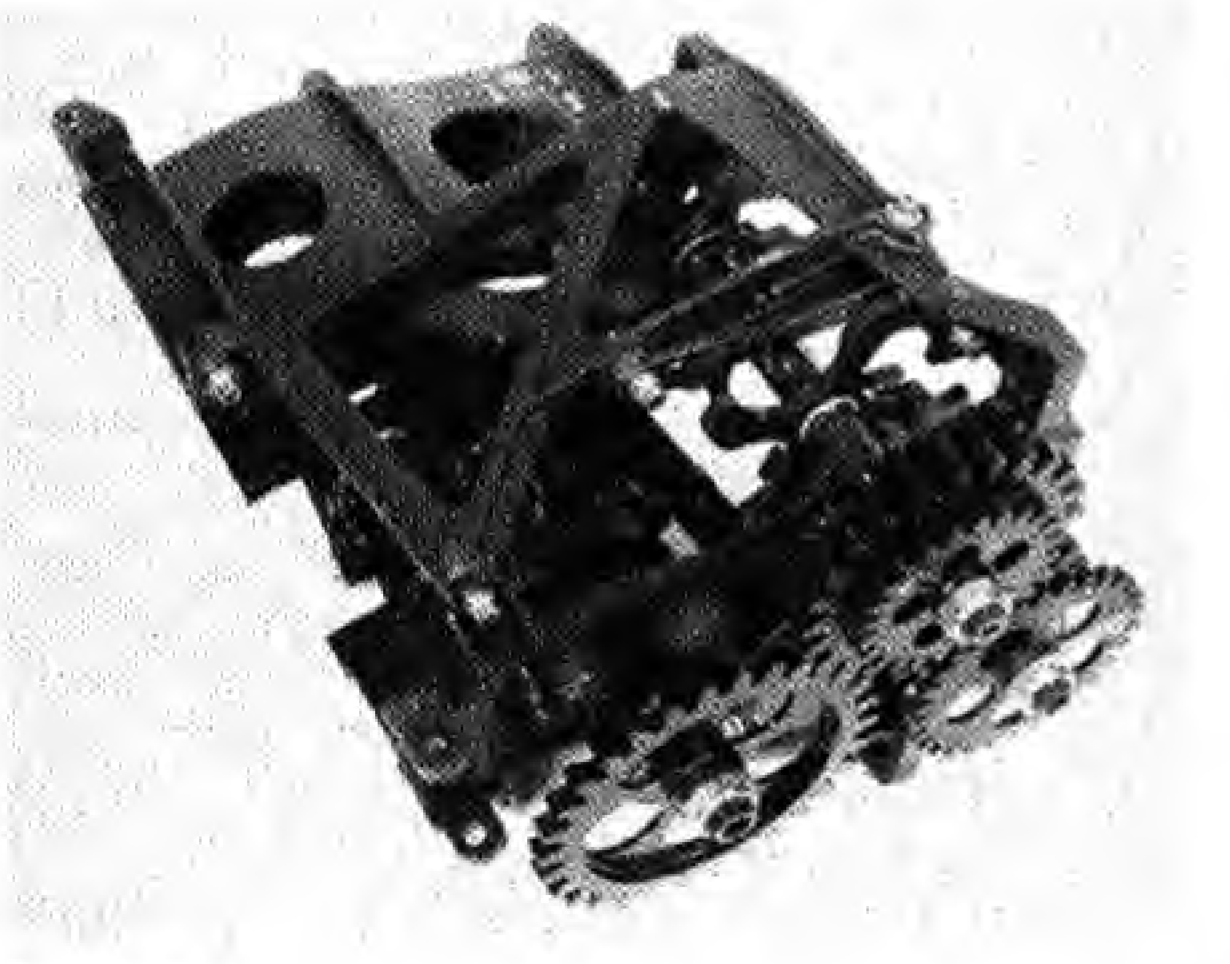
Exit Unit Round Path



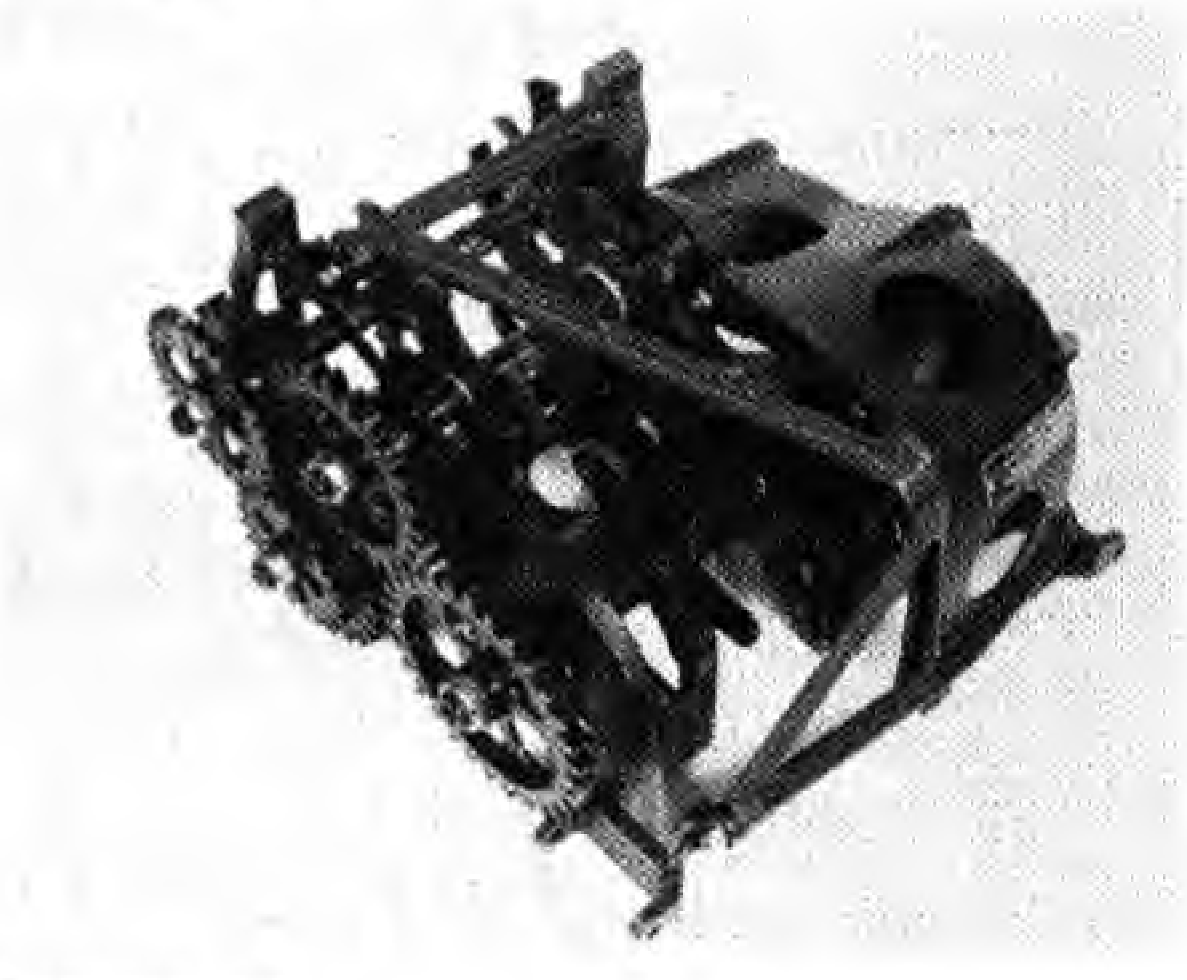
Exit Unit



Entrance Unit



Exit Unit



Entrance Unit

When the trigger signal is removed, the ECU keeps the forward solenoids energized for 70 milliseconds plus six rounds to achieve a proper clearing sequence. The ECU then energizes the reverse solenoids of both motors to stop the gun and cause it to run backwards for six consecutive fired rounds, plus two rounds. The reverse solenoids are then deenergized to complete the action and stop the gun. A pilot override can start a new burst without completing the clearing cycle.

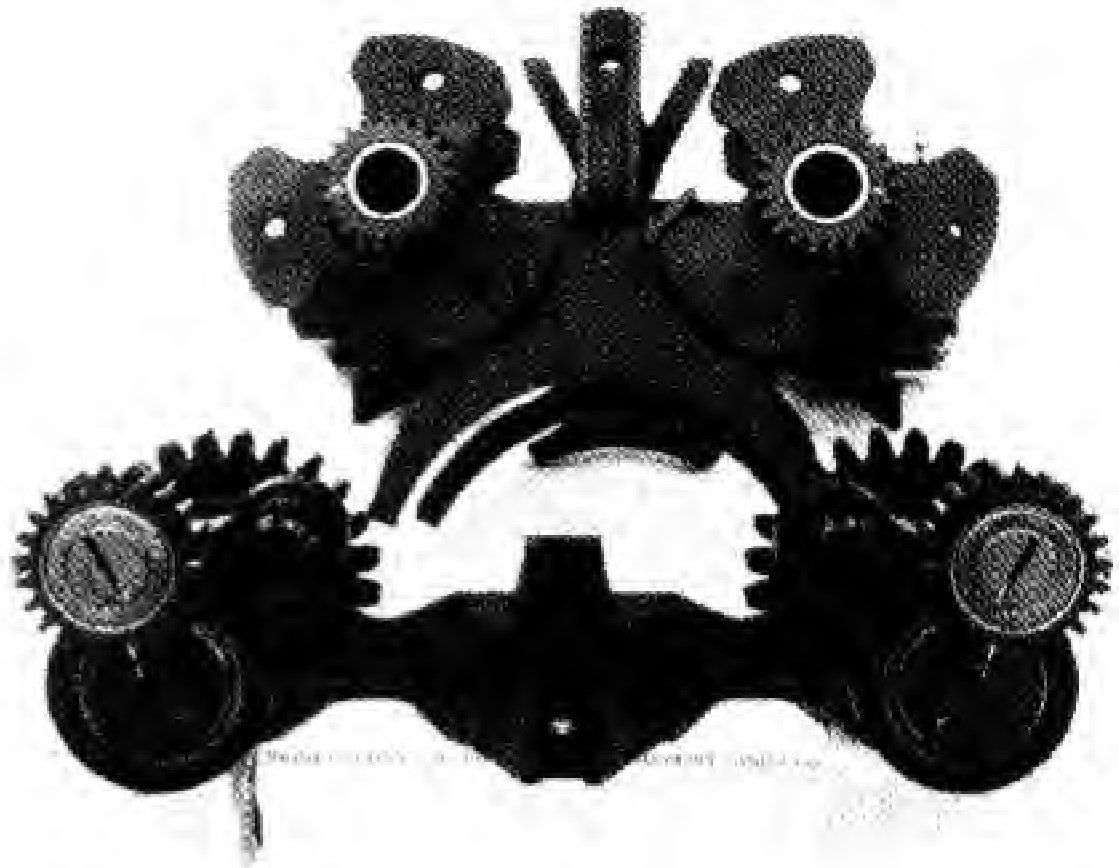
Applications of the Avenger - GAU-8/A 30mm Gun System

A-10 Close-Air-Support Aircraft. The Avenger, GAU-8/A, 30mm Gun System was specifically designed for the A-10 Close-Air-Support Aircraft.

The A-10 and its 30mm gun were conceived from the beginning to be a unitized armament system, with the aircraft and the gun being designed to work and fit together to accomplish, without compromise, its one required mission, "to defeat heavy ground armor."

The gun muzzles were placed right up front forming a chin on the aircraft. The firing barrel is on dead-center so that as the A-10 is flown straight at its target, the Avenger is right there also to fire on the target with minimum off-center gun loads imposed on the aircraft. This was done to obtain a maximum aiming accuracy for the pilot during firing, and avoiding the need for pilot corrections as in other

Transfer Unit



Timing, Transfer Unit

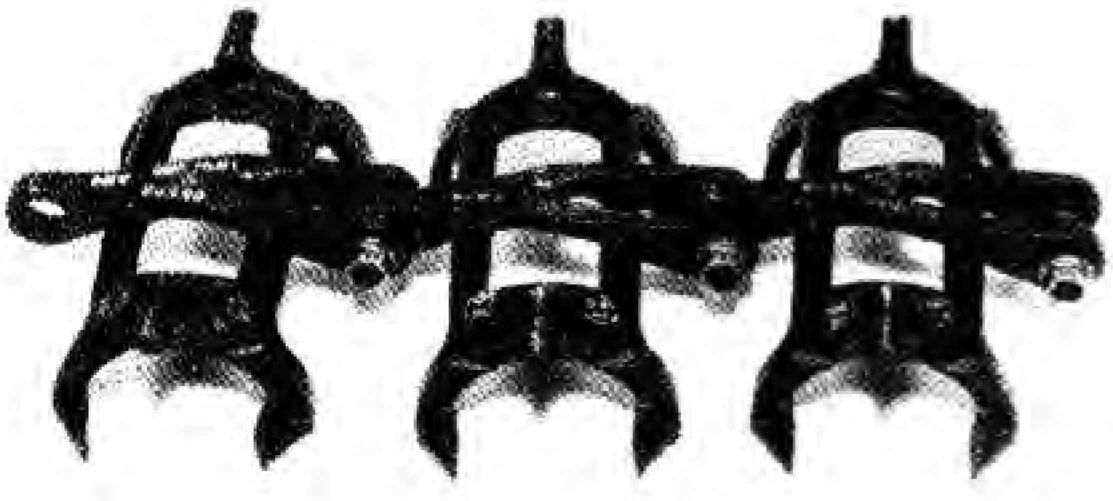
off-set fighter-gun installations.

The Linkless Feed System was placed immediately behind the gun to obtain the simplist routing of the conveyor belts between the drum and the gun. This formed a very large continuous gun and ammunition bay in the bottom forward section of the fuselage. Bottom access doors permit easy installation of the very large and heavy gun and storage drum, and for regular pre-flight servicing including the loading of its full load of 1350 rounds of ammunition.

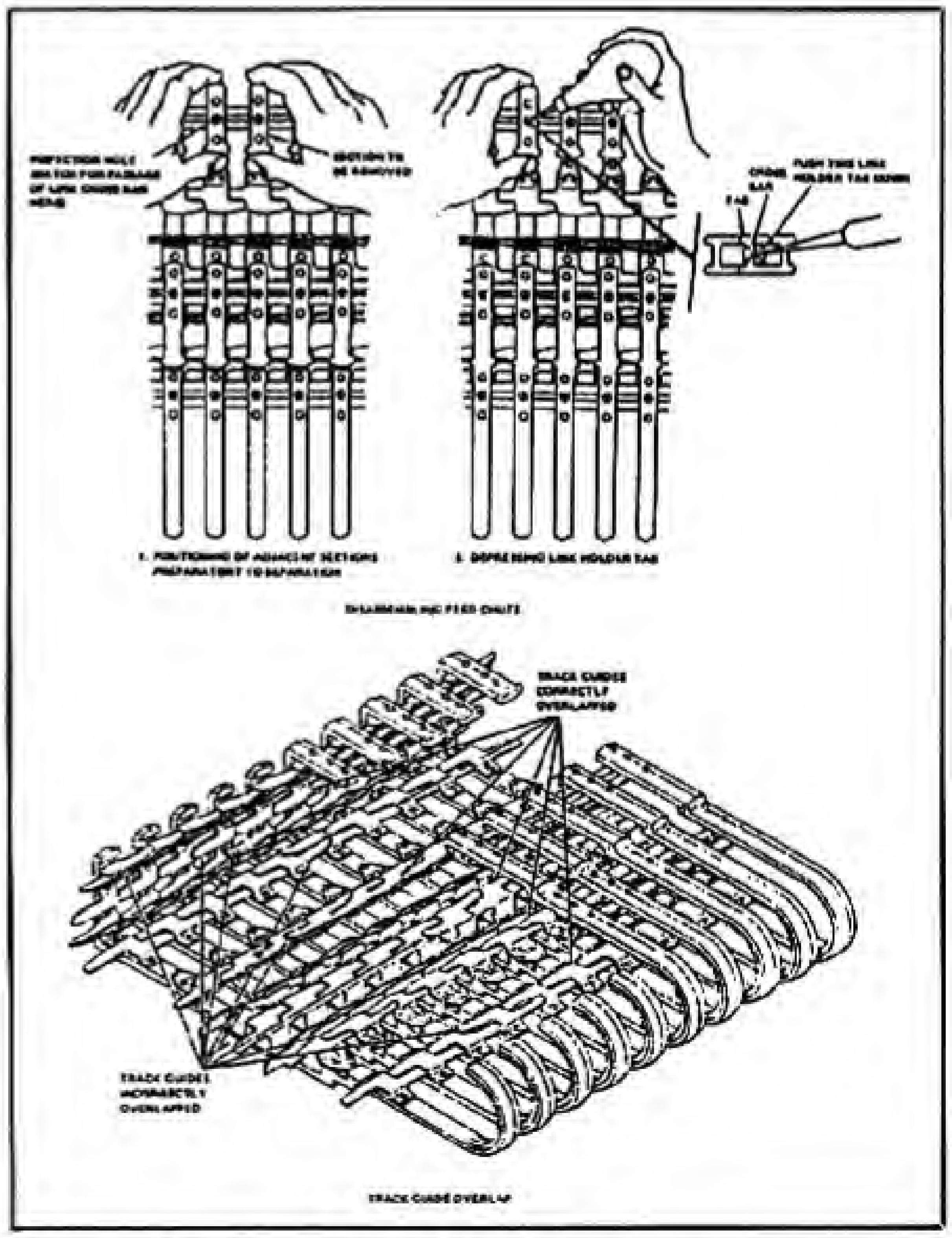
The Avenger is mounted in the forward end of the gun bay by three mounting points, with the firing barrel and the gun's 50° firing sector being on the centerline of the A-10 at a 3:00 o'clock position. This places the gun's feed and eject stations directly outboard by the port side skin. The gun has a normal firing position at the 12:00 o'clock position.

The transfer unit is assembled to the gun at this feed-eject location. The conveyor belt runs to the top side of this unit for delivering new ammo, and the bottom for removing empty cases and unfired rounds from the gun to storage in the drum.

Loading is accomplished at this same transfer unit location by opening the maintenance panel and attaching the loader unit. New ammunition is power loaded into the gun system by hand operating the



Ammunition Conveyor Elements



SECTION TO BE REMOVED
CROSS BAR
PUSH THE LINK HOLDER TAB DOWN
TAB
1. POSITIONING OF ADJACENT SECTIONS PREPARATORY TO SEPARATION
2. DEPRESSING LINK HOLDER TAB
TRACK GUIDES CORRECTLY OVERLAPPED
TRACK GUIDES INCORRECTLY OVERLAPPED
TRACK GUIDE OVERLAP

Disassembly/Assembly of Flex Chutes

Characteristics of Drive

Direction of Rotation	Reversible
Rate Capability	Dual
High Rate	4200 rds/m
Low Rate	2100 rds/m
Number of Hydraulic Drive Motors	2 independent and separate units
Input Hydraulic Power	Separate for each hydraulic drive motor. No transfer of hydraulic fluid between units.
Hydraulic Operating Pressure:	
Non-Firing	2950 psig min @ 0 gpm (0 hp)
High Rate	2578 psig @ 52 gpm (76 hp)
Low Rate	2578 psig @ 26 gpm (38 hp)
Loading	2800 psig @ 8 gpm (7.3 hp)
Electrical Power:	
Non-Firing	28 vdc @ 0 amp
Firing	28 vdc @ 12 amp
Clearing	28 vdc @ 8 amp
Manual Operation:	
Manual Control Lever	Permits bidirectional operation
Bypass Button	Permits freewheeling of hydraulic drive motor
Auxiliary Input	Provides for alternate manual or power input for loading or servicing the system
Weight (dry)	107 lbs.
Hydraulic Drive Motor:	
Type	Fixed Displacement
Motor:	
Displacement	0.975 cu in./rev
Output	32 hp (steady state)
Gearbox:	
Inputs	Dual-summed by differential action
Differential:	
Type	Bevel Gear
Reduction	2:1
Outputs	Dual-synchronized
Rotational Ratio—Forward and Reverse:	
Gun Shaft	1,000 rev
Drum Shaft	0.417 rev
Rotational Ratio—One Motor Inoperative:	
Gun Shaft	0.500 rev
Drum Shaft	0.208 rev
Gun Drive Shaft:	
Type	2-piece, splined together
Couplings:	
Gearbox End	Quick-disconnect universal
Gun End	Splined and pinned universal
Shaft Speed:	
High Rate	2400 r/min
Low Rate	1200 r/min
Reverse (1000 rds/m)	572 r/min
Drum Drive Shaft:	
Type	2-piece, splined together
Couplings:	
Gearbox End	Splined and pinned universal
Drum End	Splined and pinned universal
Shaft Speed:	
High Rate	1000 r/min
Low Rate	500 r/min
Reverse (1000 rds/m)	238 r/min

system's hydraulic motors. An ammunition trailer is used for rapid turn-around loading and carries away the discarded empty cases and unfired rounds.

The two rear gun mounts attach to the spindles of the gun's recoil adapters. The spindle ends are on a vertical line, one on top of the gun, and the other beneath. The plane of this vertical line intersects the gun just a little outboard of the firing barrel. These two mounts attach to a removable cross beam in the aircraft.

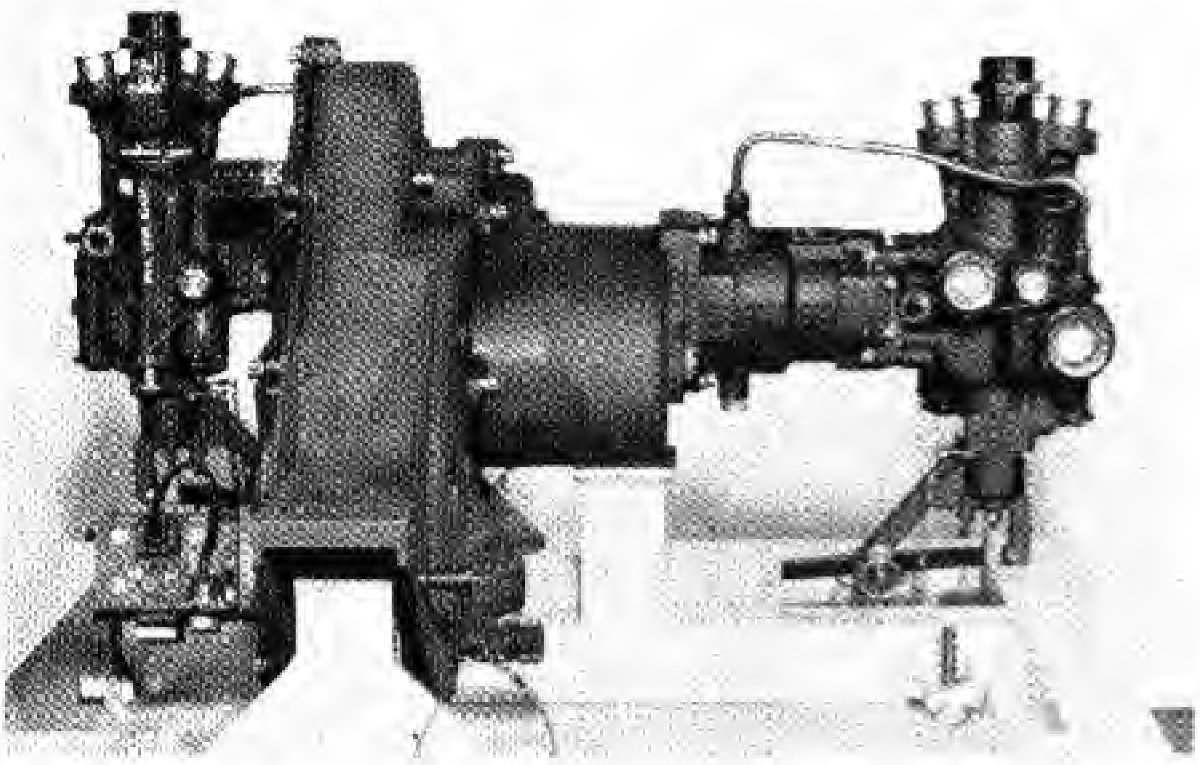
The third gun mount is located at the mid barrel clamp. The aircraft mount is a smooth inside bushing that the mid-clamp's rollers run inside of during firing. The bushing mount is bolted to the aircraft.

The main loads on the two rear mounts are from fore-aft gun recoil, and there is some vertical and side loading.

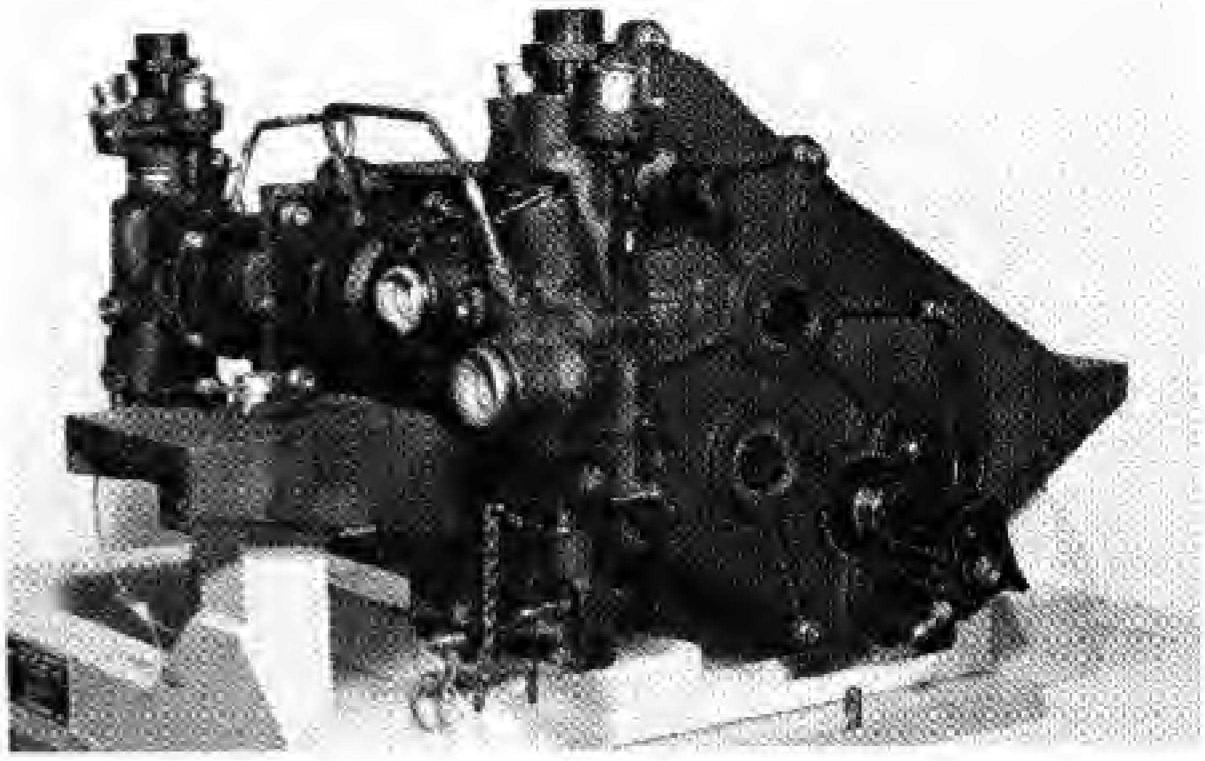
The mid barrel mount feeds only radial loads from the barrel cluster as the cluster rotates and reciprocates during firing.

A very special muzzle device was engineered and provided to direct muzzle gun gas underneath the aircraft rather than into the two engines in the rear. This solved a problem of the engines losing some power due to gun gas ingesting while the aircraft dives and fires at a ground target.

This muzzle device provides an individual chamber for each barrel. It captures the gun gas after the projectile leaves and directs the gas downward for each shot fired. The major resulting reaction to the aircraft is an upward force at the nose that is considered helpful by some pilots. There is no transverse

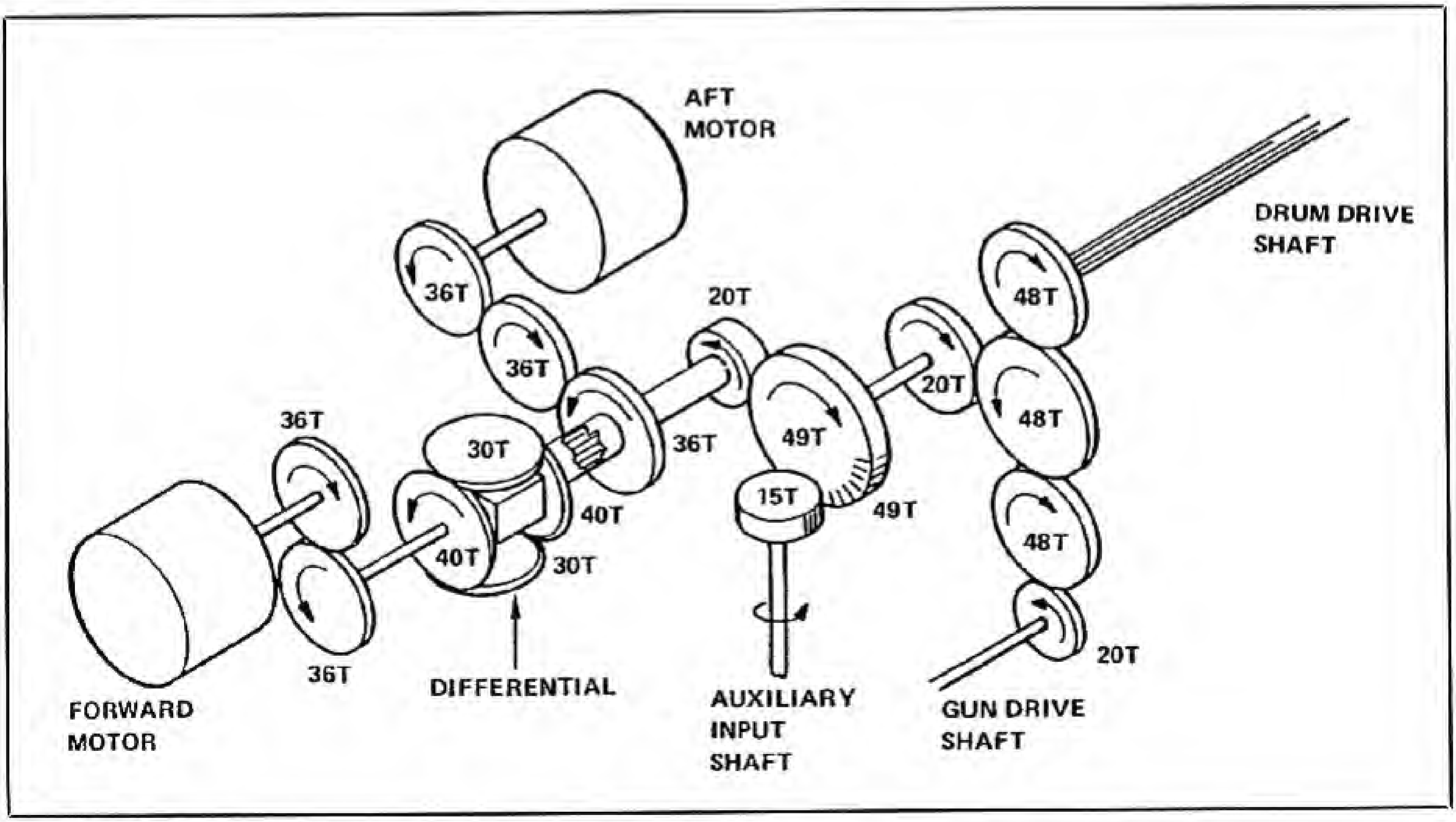


Drive Top

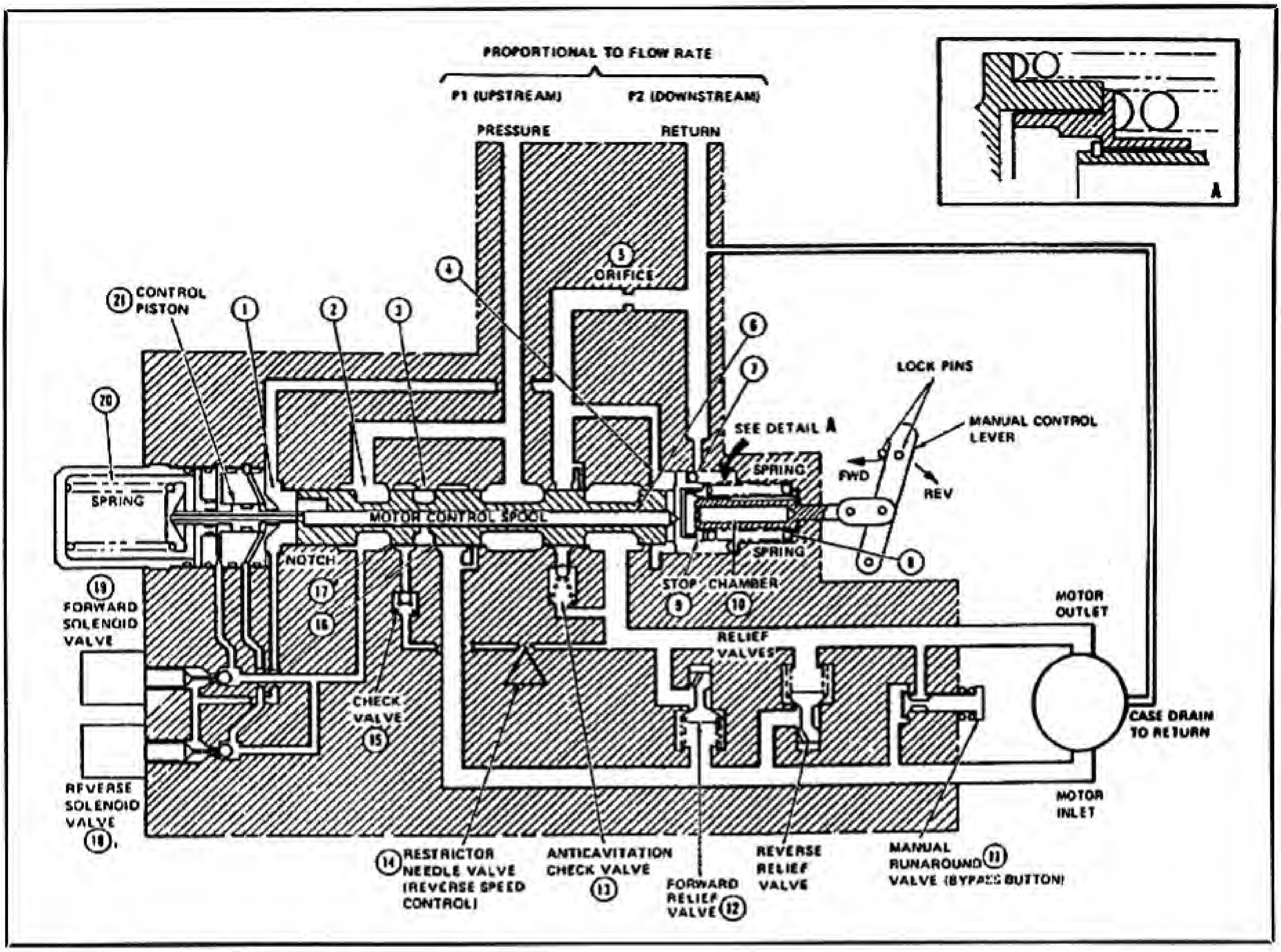


Drive Bottom

Universal Joints


AFT
MOTOR
DRUM DRIVE
SHAFT
36T
36T
20T
48T
20T
48T
36T
36T
30T
49T
15T
49T
48T
40T
40T
30T
20T
36T
DIFFERENTIAL
AUXILIARY
INPUT
SHAFT
GUN DRIVE
SHAFT
FORWARD
MOTOR

Gear Train Diagram


PROPORTIONAL TO FLOW RATE
P1 (UPSTREAM)
P2 (DOWNSTREAM)
PRESSURE
RETURN
A
④
⑤ ORIFICE
㉑ CONTROL PISTON
①
②
③
⑥
⑦
LOCK PINS
⑳
SEE DETAIL A
MANUAL CONTROL LEVER
SPRING
FWD
REV
SPRING
MOTOR CONTROL SPOOL
NOTCH
SPRING
⑧
⑲ FORWARD SOLENOID VALVE
⑰
⑯
STOP ⑨
CHAMBER ⑩
MOTOR OUTLET
RELIEF VALVES
CHECK VALVE ⑮
CASE DRAIN TO RETURN
REVERSE SOLENOID VALVE ⑱
MOTOR INLET
⑭ RESTRICTOR NEEDLE VALVE (REVERSE SPEED CONTROL)
ANTICAVITATION CHECK VALVE ⑬
FORWARD RELIEF VALVE ⑫
REVERSE RELIEF VALVE
MANUAL RUNAROUND ⑪ VALVE (BYPASS BUTTON)

Hydraulic Drive Motor Diagram

loads produced which would be harmful to keeping the aircraft on target.

Goalkeeper

The Goalkeeper System makes use of the Avenger GAU-8/A 30mm gun and a double-ended Linkless Feed System for close-in defense of ships from high speed missiles and aircraft. The gun system is electrically driven to fire the system at 4200 shots per minute.

The ammunition system contains 1125 rounds. It is reloaded in a sheltered area by a hand-operated loader with extra loose ammunition carried on board.

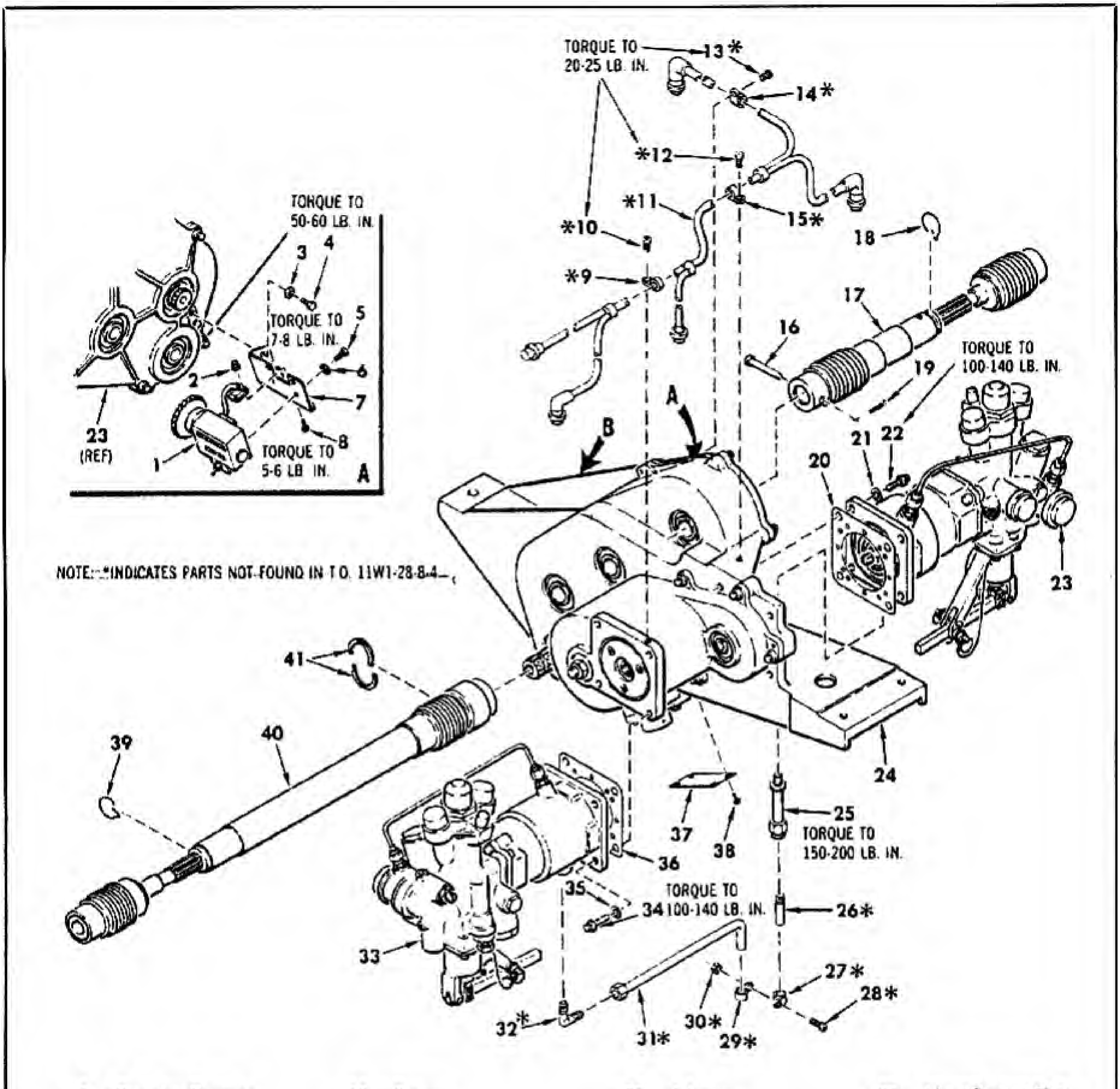
Goalkeeper is a joint effort of Hollandse Signaalapparaten B.V. of the Netherlands and General Electric.

The mount system is a high performance, lightweight, compact system with inherent high pointing accuracy. The mount is driven by separate train and elevation axis servo drives feeding two drive motors in elevation and four drive motors in train.

Particular design emphasis has been placed on the positioning of the gun relative to the train and elevation axes of the mount to allow reliable ammunition feed to the gun. The mount's elevation axis passes through the center of the gun's transfer unit, which minimizes chuting distortion as the gun is elevated or depressed.

Gun firing torques have been minimized by intersecting the centerline of the gun's firing barrel with the centerline of both the train and elevation axes.

The ammunition feed/storage drum is mounted vertically and rotates in the train axis. This configuration minimizes unbalanced loads and inertia changes as the quantity of ammunition varies. This design also reduces the above deck profile of the mount, and minimizes the swept radius required below deck.

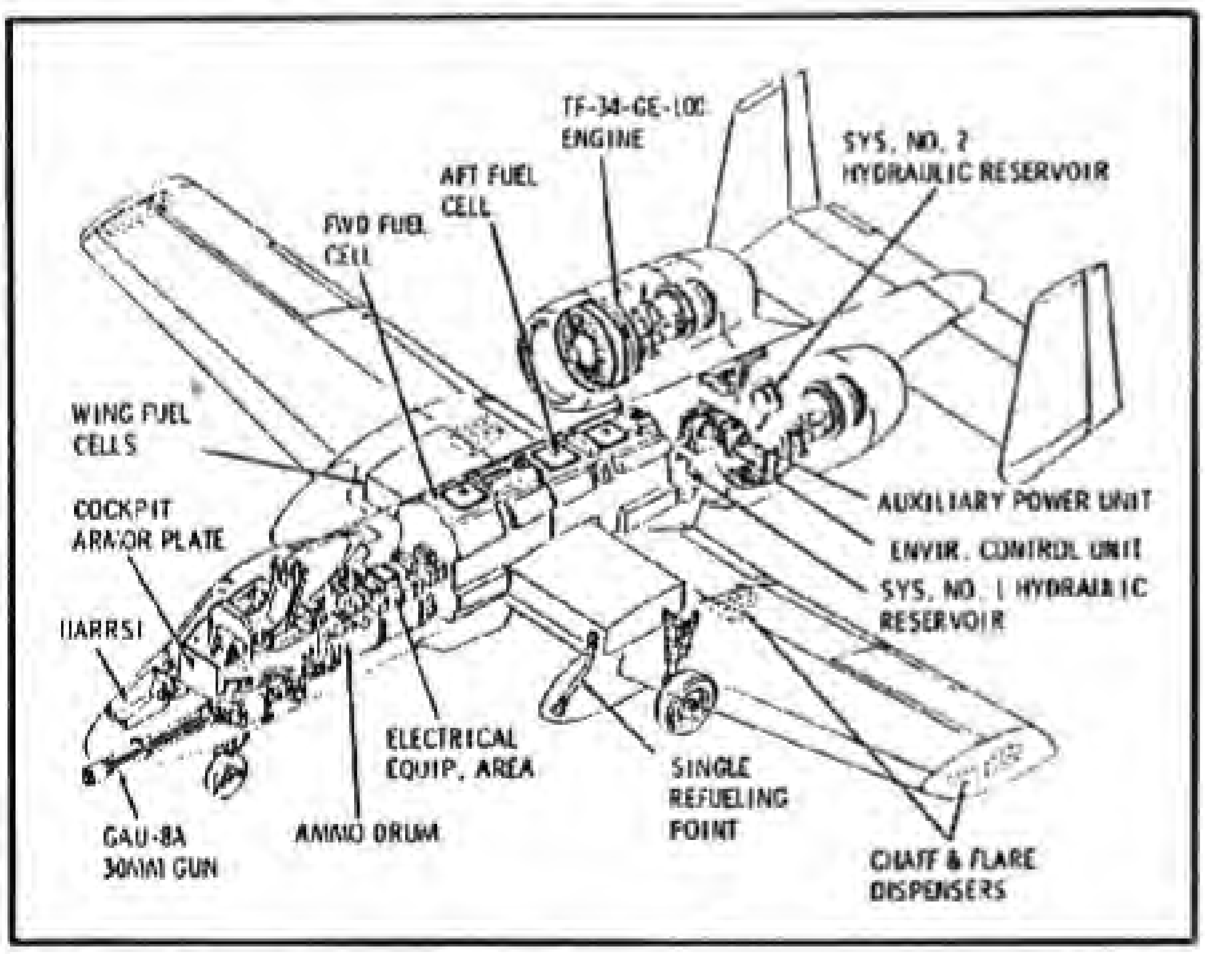

TORQUE TO 20-25 LB. IN.
13*
14*
*12
*11
15*
*10
18
*9
17
16
TORQUE TO 100-140 LB. IN.
19
A
B
21
22
20
TORQUE TO 50-60 LB. IN.
3
4
TORQUE TO 7-8 LB. IN.
5
6
2
7
23 (REF)
1
TORQUE TO 5-6 LB IN.
8
A
23
41
39
40
24
25
TORQUE TO 150-200 LB. IN.
37
38
36
35
34
TORQUE TO 100-140 LB. IN.
26*
33
27*
28*
32*
30*
31*
29*

NOTE: *INDICATES PARTS NOT FOUND IN T.O. 11W1-28-8-4

1	Rotating Counter	13	Screw	25	Adapter	37	Identification Plate
2	Nut	14	Cable Clamp	26	Tube	38	Screw
3	Washer	15	Cable Clamp	27	Cable Clamp	39	Retaining Ring
4	Bolt	16	Pin	28	Screw	40	Gun Drive Shaft
5	Screw	17	Drum Drive Shaft	29	Cable Clamp	41	Retaining Ring
6	Washer	18	Retaining Ring	30	Nut	42	Nut
7	Rounds Counter Bracket	19	Pin	31	Tube	43	Shaft
8	Screw	20	Gasket	32	Elbow	44	Bolt
9	Cable Clamp	21	Washer	33	Hydraulic Drive Motor	45	Washer
10	Screw	22	Bolt	34	Bolt	46	Spacer
11	Cable W3	23	Hydraulic Drive Motor	35	Washer	47	Lubricator
12	Screw	24	Accessory Drive Gearbox	36	Gasket		

Drive (Exploded View)

A-10 Aircraft (User of GAU-8/A)


TF-34-GE-100 ENGINE
SYS. NO. 2 HYDRAULIC RESERVOIR
AFT FUEL CELL
FWD FUEL CELL
WING FUEL CELLS
COCKPIT ARMOR PLATE
IIARRSI
AUXILIARY POWER UNIT
ENVIR. CONTROL UNIT
SYS. NO. 1 HYDRAULIC RESERVOIR
ELECTRICAL EQUIP. AREA
SINGLE REFUELING POINT
GAU-8A 30MM GUN
AMMO DRUM
CHAFF & FLARE DISPENSERS

Internal Arrangement

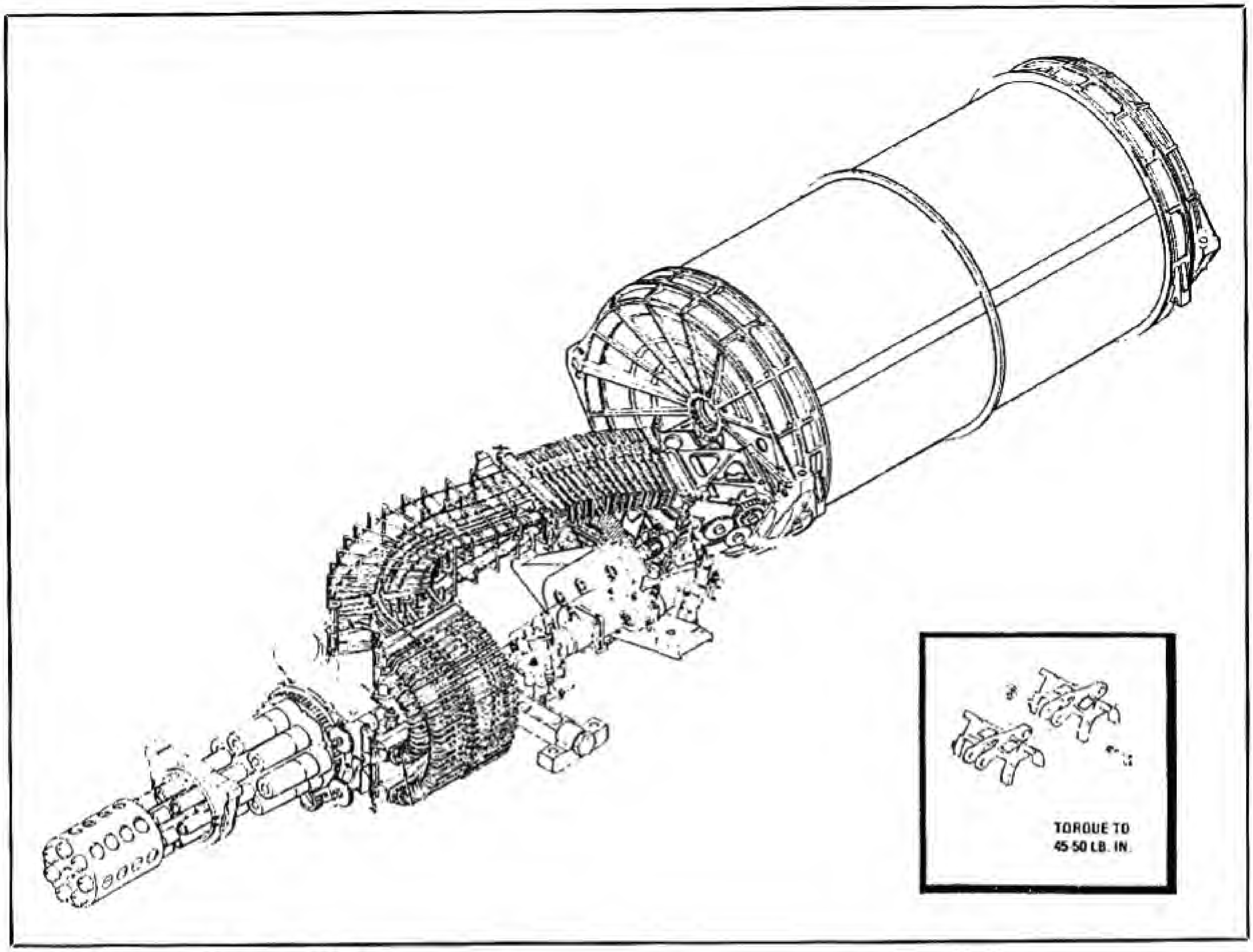
A-10 Facts and Figures

Designer and Manufacturer	Fairchild Republic Co. Division of Fairchild Industries
Primary Mission	Sustained close air support
Powerplant	Two General Electric TF34-GE-100 turbofan engines, each about 9,000 lbs. (4,082 kg) of thrust
Length	53 ft. 4 in. (16.25 m)
Height	14 ft. 8 in. (4.47 m)
Wingspan	57 ft. 6 in. (17.53 m)
Internal Fuel Capacity	10,700 lbs. (4,853 kg)
Operating Weight	25,000 lbs. (11,340 kg)
Maximum Gross Weight	50,000 lbs. (22,680 kg)
Armament	One 30mm General Electric GAU-8 seven-barrel Gatling Gun
Ammunition Capacity	1,174/1,350 rounds
Firing Rate	2100/4200 rpm
Ordnance Capacity	Up to 16,000 lbs. (7,257 kg) of mixed ordnance including pylon stations
Takeoff Distance with 4-500 lb. (227 kg) bombs, 750 rds. 30mm, 4,000 lb. (1,814 kg) fuel	1,420 ft. (433 m)
Distance at Maximum Takeoff Weight	4,000 ft. (1,220 m)
Ferry Range without Inflight Refueling	2,173 nautical miles into a 50 knot (93 km/hr) headwind
Combat speed with 6-500 lb. (227 kg) bombs, 750 rounds, 30 mm	387 knots (717 km/hr)
Loiter Time with 250 NM (463 km) radius, 18-500 lbs. (227 kg) bombs, 750 rounds, 30mm	1.75 hours
Crew	Pilot only
Fire Control System	Head-up display, TV monitor and control, armament control system, and laser spot seeker set
Deployment	A-10's are operational in the U.S. Tactical Air Command, U.S. Air Forces Europe, Air National Guard and Air Force Reserves

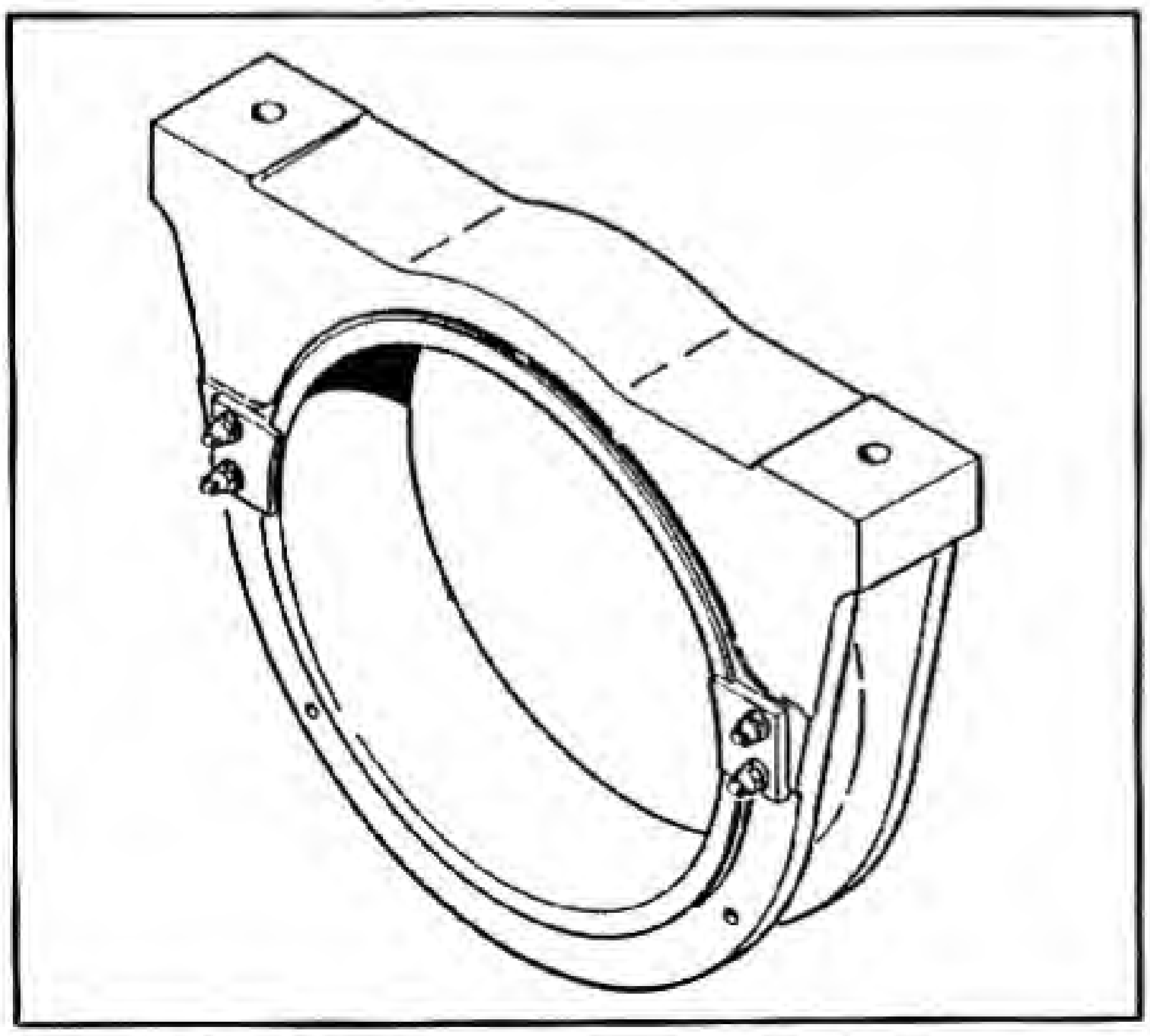
The below deck location of the drum assembly also provides a protected environment for loading and maintenance.

Doors and access panels have been incorporated in the design to facilitate maintenance activities. The rear cradle, which supports the gun, is capable of being placed in a service position. This allows easy access to most of the gun's serviceable components.

For soft targets and training purposes the system is capable of firing piercing incendiary, and target practice rounds. The operational ammunition is an Armor Piercing Discarding Sabot (APDS) round. The APDS projectile contains a high-density tungsten alloy penetrator, and embodies the lethality against


TORQUE TO
45 50 LB. IN.

GAU-8/A Avenger Armament System



Forward Gun Mount

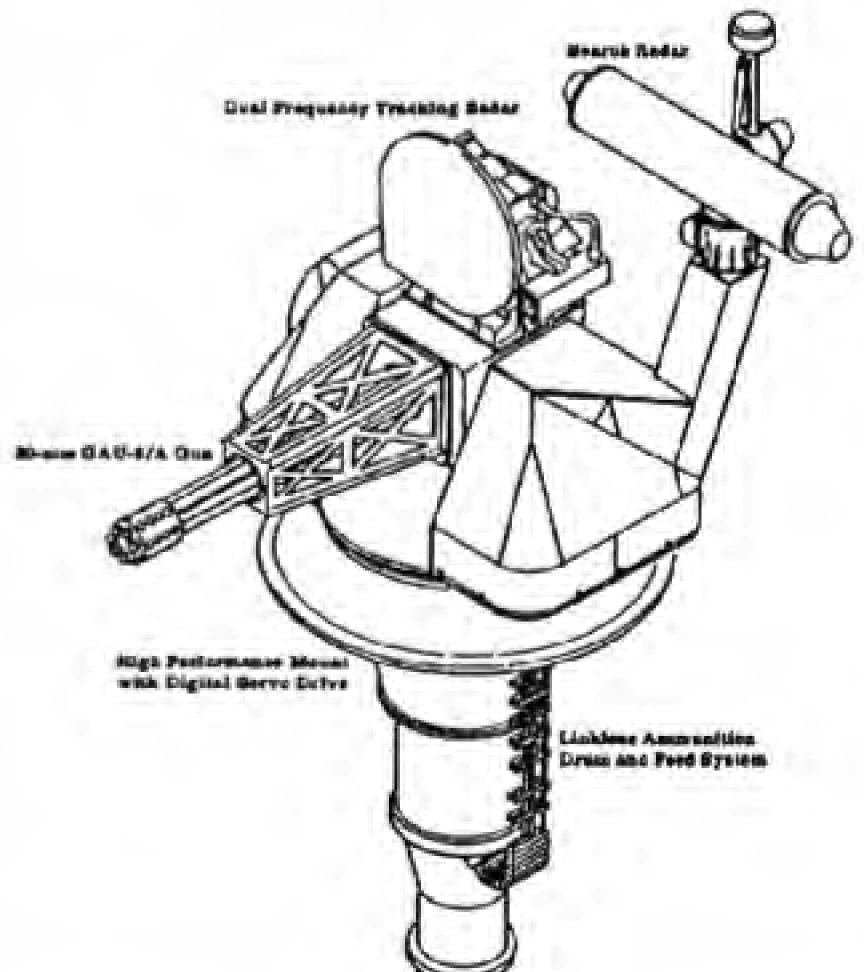
GAU-8 Blast Diverter

Goalkeeper

current and future missile threats. Its terminal effectiveness ensures warhead kills.

The Mount Control Electronics is separate from the mount and can be located anywhere within 20 meters of the mount. It is packaged in three cabinets, assembled together, and mounted on shock and vibration isolators. The Mount Control Electronics provides the control logic and power amplifiers required by the Goalkeeper Mount for interfacing with the fire control system and driving the mount. The Mount Control Electronics also contains a control and maintenance panel which allows the mount to be controlled independently of the fire control system.

The gun control electronics contains all of the logic and control electronics required to safely arm, fire, and clear the gun. The gun control electronics also contains the loading control circuitry and the battery charging circuitry. The gun control electronics are packaged in a three-way cabinet assembly which is mounted on one of the drum supports.


Search Radar
Dual Frequency Tracking Radar
30-mm GAU-8/A Gun
High Performance Mount with Digital Servo Drive
Linkless Ammunition Drum and Feed System

GAU-8/A 30mm "Goalkeeper" Weapons System

GAU-8/A Ammunition

The techniques used by the U.S. Air Force to procure 30mm ammunition for the A-10 aircraft system have proven to be exceptionally efficient.

The 30mm GAU-8/A ammunition program began in 1972 in support of the GAU-8 guns to be installed in the A-10 aircraft.

Because of the tight schedule imposed for the A-10 system, the U.S. Air Force decided to break with tradition and use industry to build the ammunition. Previously ammunition of this calibre size had been developed and built by the U.S. arsenals.

General Electric teamed with Aerojet Ordnance Company to supply the ammunition for its gun. As a result, Aerojet was selected as the first source for ammunition supply. The second source, Honeywell, was selected on the basis of competition nine months later in February 1974.

The GAU-8/A 30mm ammunition consists of a family of ballistically matched projectiles which are currently under development. They include Target Practice (TP), High Explosive Incendiary (HEI) and Armor Piercing Incendiary (API) rounds which are designed to defeat a wide range of close air support targets such as trucks, armored personnel carriers and medium and heavy tanks. The HEI round employs a standard M505 fuze and explosive mix with a body of naturally fragmenting material that is effective against lighter vehicle and material targets. The API round has a lightweight body which contains a subcalibre high density penetrator of depleted uranium. The ballistics are optimized to provide the maximum remaining energy at combat ranges sufficient to defeat tanks and armored personnel carriers.

The GAU-8/A ammunition incorporates aluminum cartridge cases which reduce system weight significantly over brass or steel cases. The round is percussion primed and the projectile uses plastic rotating bands instead of the conventional copper or steel bands which they hoped would improve barrel life.

At the time of the GAU-8 ammunition development, the use and production of depleted uranium was in its infancy. The production capability in the United States was less than five percent of the needed volume for the GAU-8 requirement.

Depleted uranium is used to make the penetrator in the armor piercing projectile and is the basis for the exceptional tank-killing power of the A-10 system. Depleted uranium is extremely effective for the destruction of armor because of its penetration capability due to density and its pyrophoric property at impact. The pyrophoric property ignites the fuel and ammunition located within the tank after penetration. Depleted uranium is also lower in cost and is a non-critical material in comparison with tungsten, which had previously been used for penetrators.

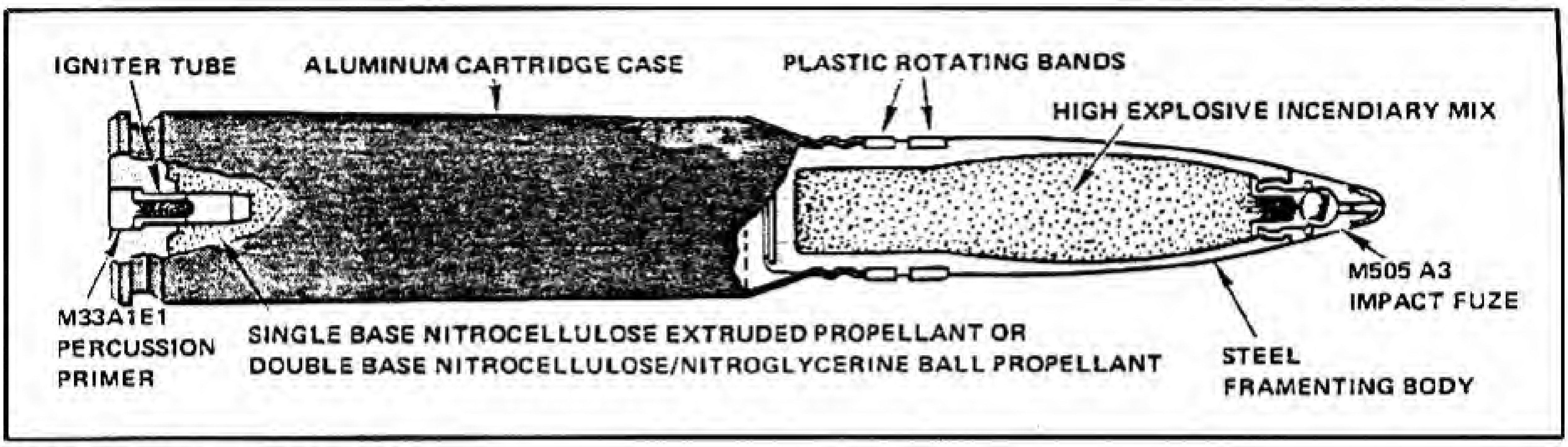
Depleted uranium is a by-product of the overall uranium refining process. Large quantities of this safe (very low radiation) metal exist in government inventories in the form of "green salt" (UF_4). At the start of the GAU-8 ammunition program, however, little was known about the production of the basic metal from this green salt and the techniques for forming and machining it. Also needed was information on all of the environmental aspects for safe manufacture and use. This was the task that was attacked in a timely fashion by the Air Force manufacturing technology program. As a result, a new material (depleted uranium) moved smoothly and economically into a production status. Depleted uranium is now being applied to a wider range of

Ammunition Characteristics

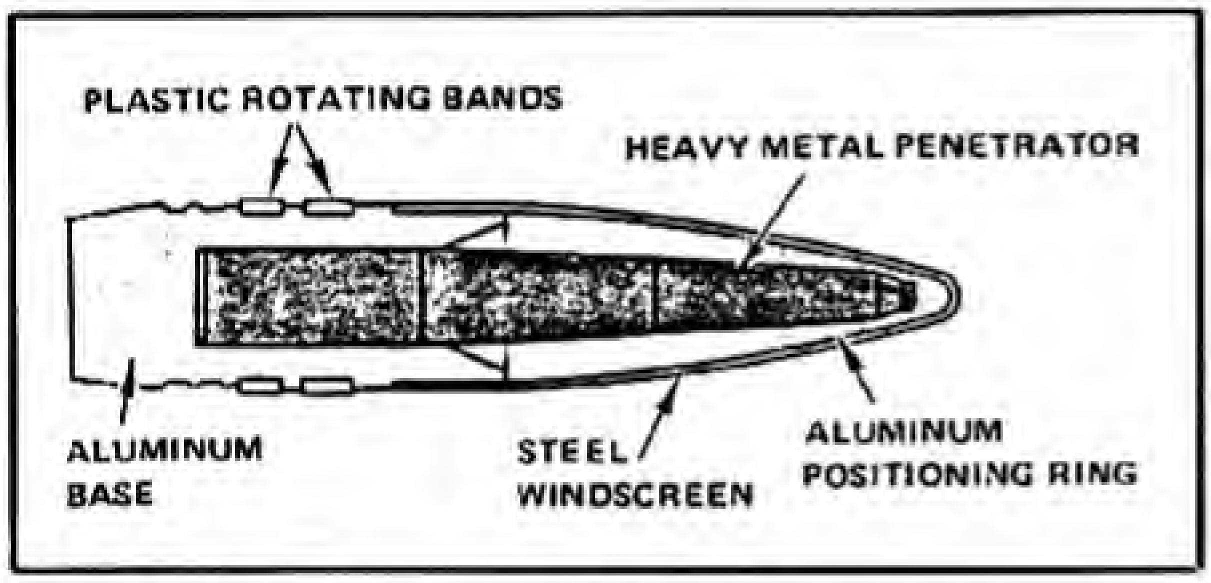
GAU-8/A	TP/HEI	API (Honeywell)	API (AOC)
Cartridge Weight	1,530 lb. (694 gms.)	1.58 lb. (717 gms.)	1.65 lb. (748 gms.)
Projectile Weight	0.814 lb. (370 gms.)	.864 lb. (390 gms.)	.948 lb. (430 gms.)
Case Weight	0.322 lb. avg. (146 gms.)	—	—
Propellant Weight	148-156 gms.	150-156 gms.	150-156 gms.
HE Weight	56 gms. min.	X	X
Cartridge Length	11.416 in. max. (290mm)	—	—
Projectile Length	5.49 in. max. (140mm)	—	—
Case Length	6.811 in. max. (173mm)	—	—
Muzzle Velocity	3,400 fps (1,036 m/sec.)	3,375 fps (1,030 m/sec.)	3,215 fps (980 m/sec.)

ammunition calibres, such as 20mm, 105mm, and 120mm, and in shaped-charge and self-forging fragment warheads.

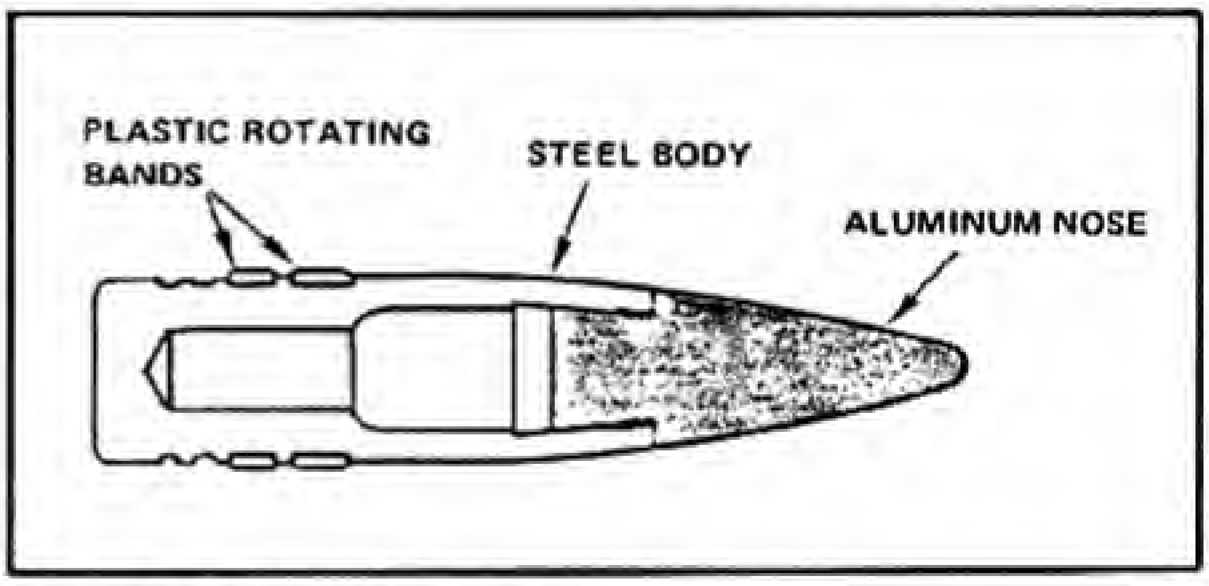
Early in the combat-type test program, a problem was uncovered in the production ammunition and quickly corrected. This problem, which involved a projectile windscreen, had not shown up in ground testing and could have resulted in the storage of defective ammunition in the War Reserve Material stockpile.


IGNITER TUBE
ALUMINUM CARTRIDGE CASE
PLASTIC ROTATING BANDS
HIGH EXPLOSIVE INCENDIARY MIX
M505 A3
IMPACT FUZE
M33A1E1
PERCUSSION
PRIMER
SINGLE BASE NITROCELLULOSE EXTRUDED PROPELLANT OR
DOUBLE BASE NITROCELLULOSE/NITROGLYCERINE BALL PROPELLANT
STEEL
FRAMENTING BODY

High Explosive Incendiary (HEI)


PLASTIC ROTATING BANDS
HEAVY METAL PENETRATOR
ALUMINUM
BASE
STEEL
WINDSCREEN
ALUMINUM
POSITIONING RING

Armor Piercing Incendiary (API)

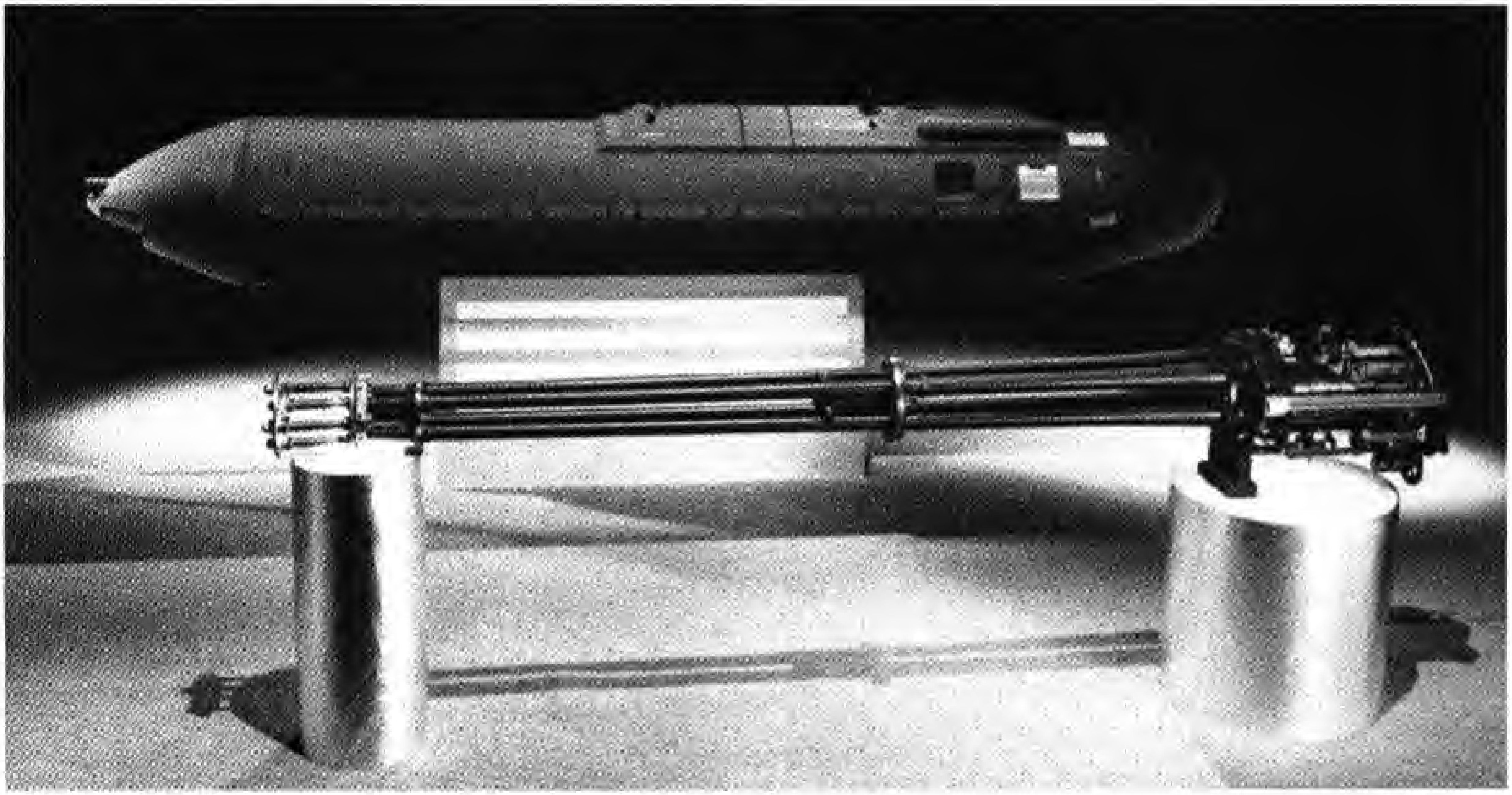

PLASTIC ROTATING
BANDS
STEEL BODY
ALUMINUM NOSE

Target Practice (TP)

Chapter 13

30mm GAU-13/A FOUR BARREL AVENGER GUN

GENERAL ELECTRIC



GAU-13/A Four Barrel Avenger Gun and GPU-5/A Gun Pod

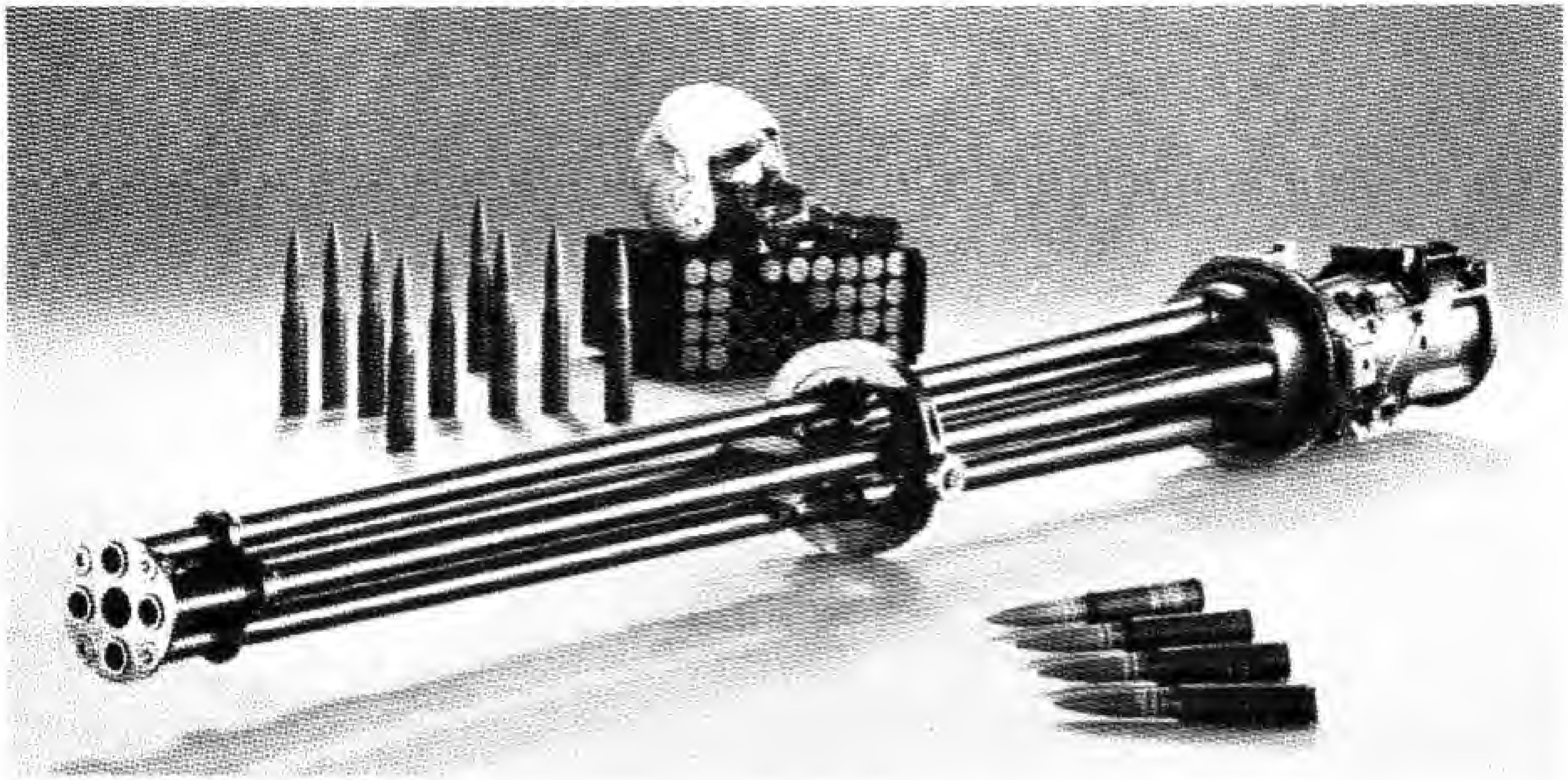
Introduction

The Four Barrel Avenger GAU-13/A is the lightweight variation of the original Avenger, the seven barrel, 30mm GAU-8/A gun used on the Air Force A-10.

The new GAU-13/A was designed, from the beginning, using GAU-8/A details and materials in order to obtain the smallest and lightest 30mm gun for the GPU-5/A gun pod for the Air Force. The gun weighs one-half of that of the Avenger gun. It is also very much like the five barrel 25mm Equalizer GAU-12/U used on the U.S. Marines Harrier AV-8B.

These three guns represent the latest in weapons technology and metallurgy, firing large calibre, high energy projectiles of various designs for special target effects. Together with the 20mm Vulcan and the 7.62mm Minigun, these five high rate guns have been in production at the General Electric Company since 1956, starting at various times, and, some are still in production in 1986. They all revert back to Richard J. Gatling for the basic principle of operation he invented in1864. However, today's weapons have demonstrated their ability to provide sustained, reliable, high rate of fire on many modern day military platforms into 1986.

The four barrel GAU-13/A is pneumatically driven to fire at 2400 shots per minute on the GP-5/A



GAU-13/A Lightweight 30mm Gun

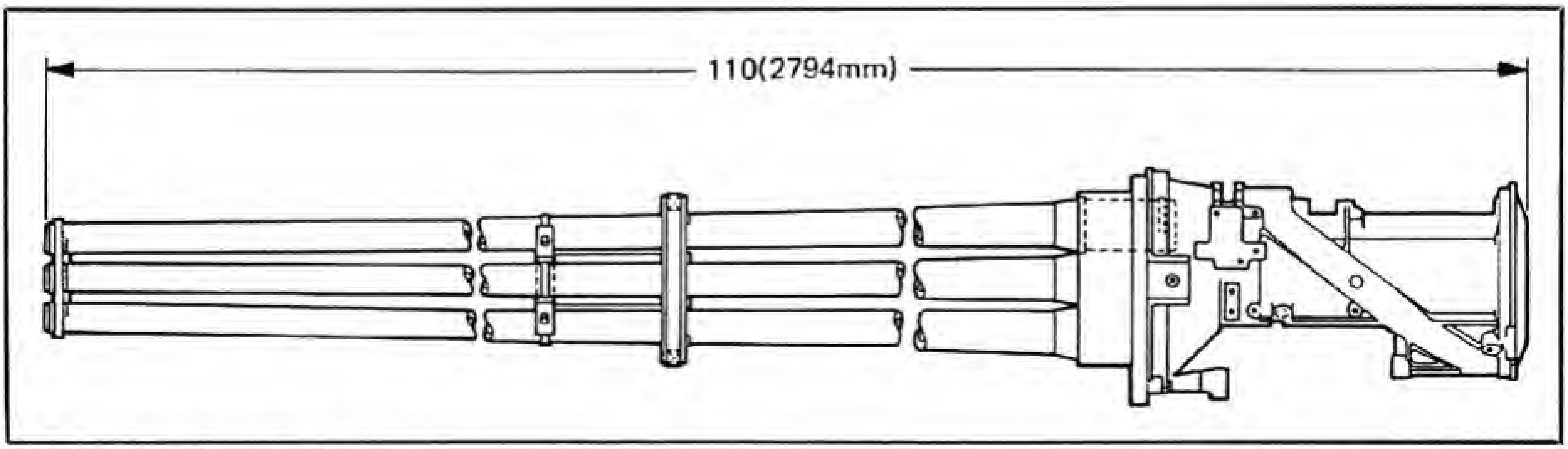
Air Force A-10

Gun Pod. A very unique double helix linkless feed system is used to feed the gun which reverses rotation during gun clearing and loading.

History

The four barrel GAU-13/A 30mm gun was started in preliminary design, at the General Electric Company in February 1976, on an Independent Research and Development Project. From the first it was designated to fire in the GPU-5/A gun pod which also started development at the same time.

The design and manufacture of the prototype gun went rapidly and in just over a year the first test unit gun had fired in March 1977. Likewise, the first gun pod had passed through design and building. How-



GAU-13/A Lightweight 30mm Gun

ever, the new double helix feed system, the pneumatic gun drive and the combining of the gun to these components necessitated additional design work and further component tests. It required one-and-a-half years to complete the pod prototype that first fired in September 1978 at the General Electric Company test facility.

Flight tests soon followed at Edwards Air Force Base on an F5 aircraft in February 1979 and on an A-7 aircraft at Vought the following month.

The flights and firings were very successful, proving compatibility with these aircraft in various flight maneuvers including air-to-ground gunnery. It took another year, however, to complete contractual details so that by July 1980, the General Electric Company was able to start manufacture of the GPU-5/A Gun Pod with the GAU-13/A 30mm gun.

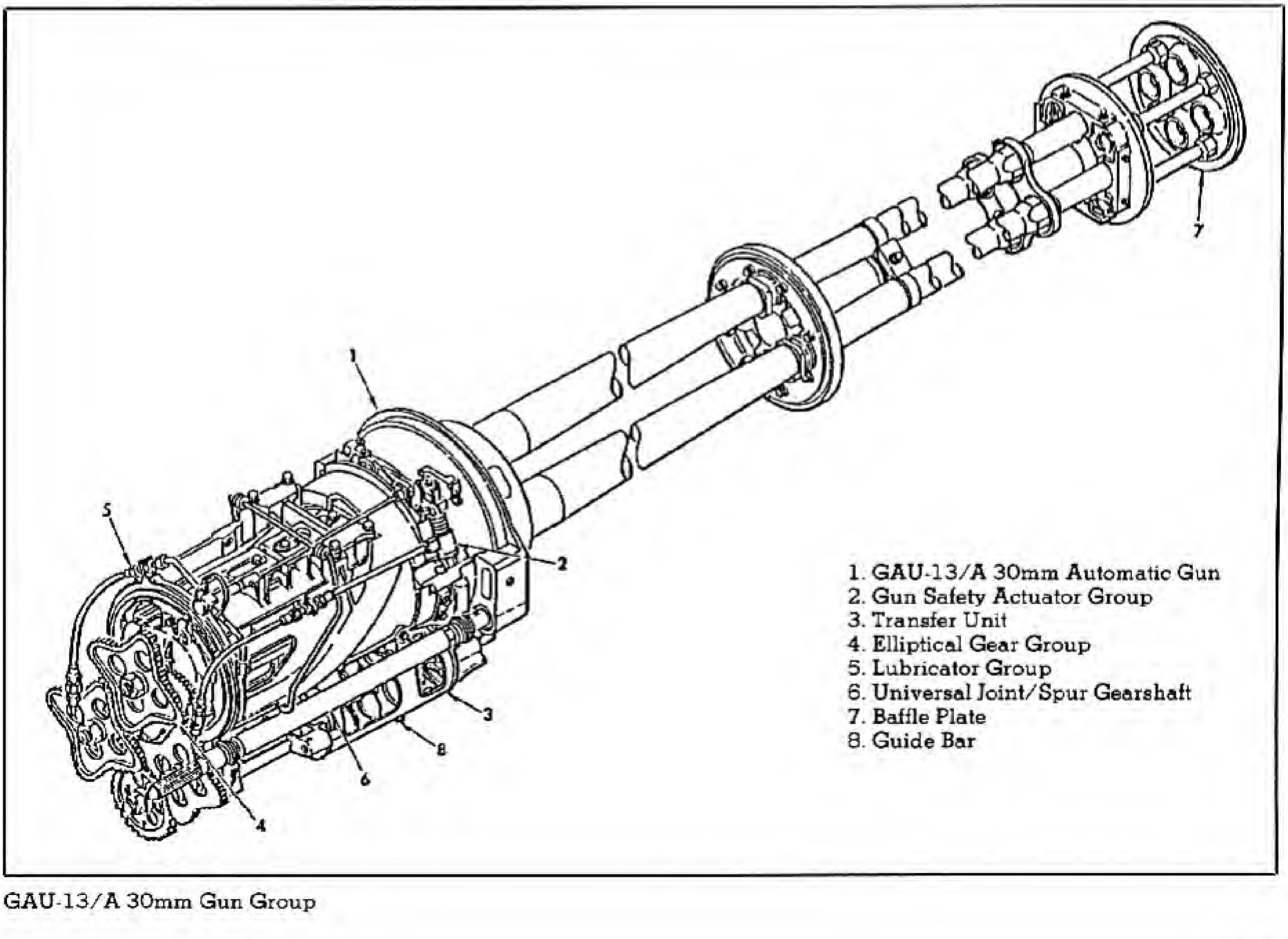
The first production pod was delivered to the Air Force in September 1982. Since that time, 329 gun pods have been sent to the Air Force with the last one leaving the General Electric Company in April 1986.

Operation and Description

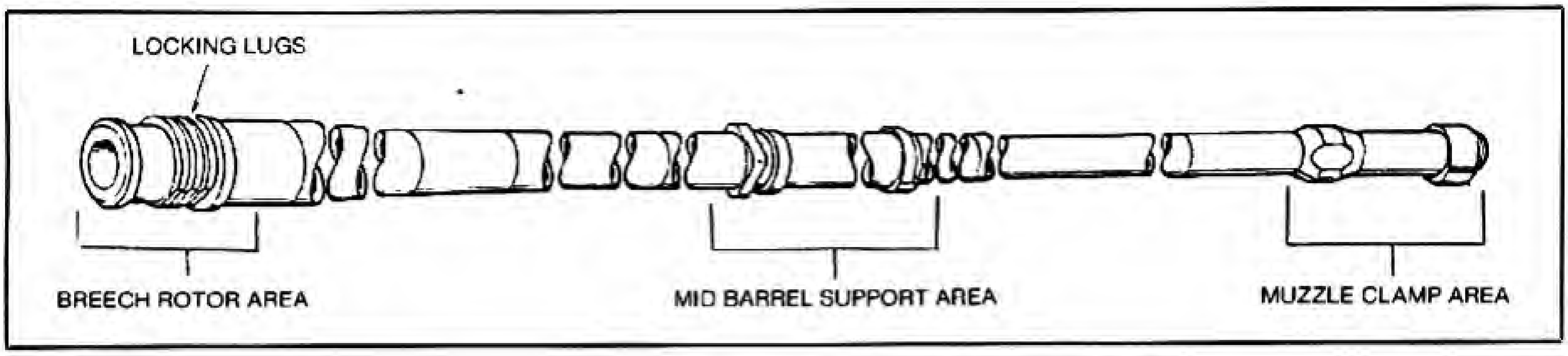
The 30mm gun GAU-13/A is an air cooled, four barrel, Gatling-type weapon whose 2400 shots-per-minute rate of fire in the GPU-5/A gun pod can destroy a variety of heavily armored ground targets. The gun is a lightweight version of the seven barrel GAU-8/A Avenger.

This gun contains four barrels held together in a circular cluster. Interrupted locking lugs on each barrel engage similar lugs in the forward rotor, securing the barrels longitudinally to the rotor. Mid and muzzle clamps hold the barrels to each other.

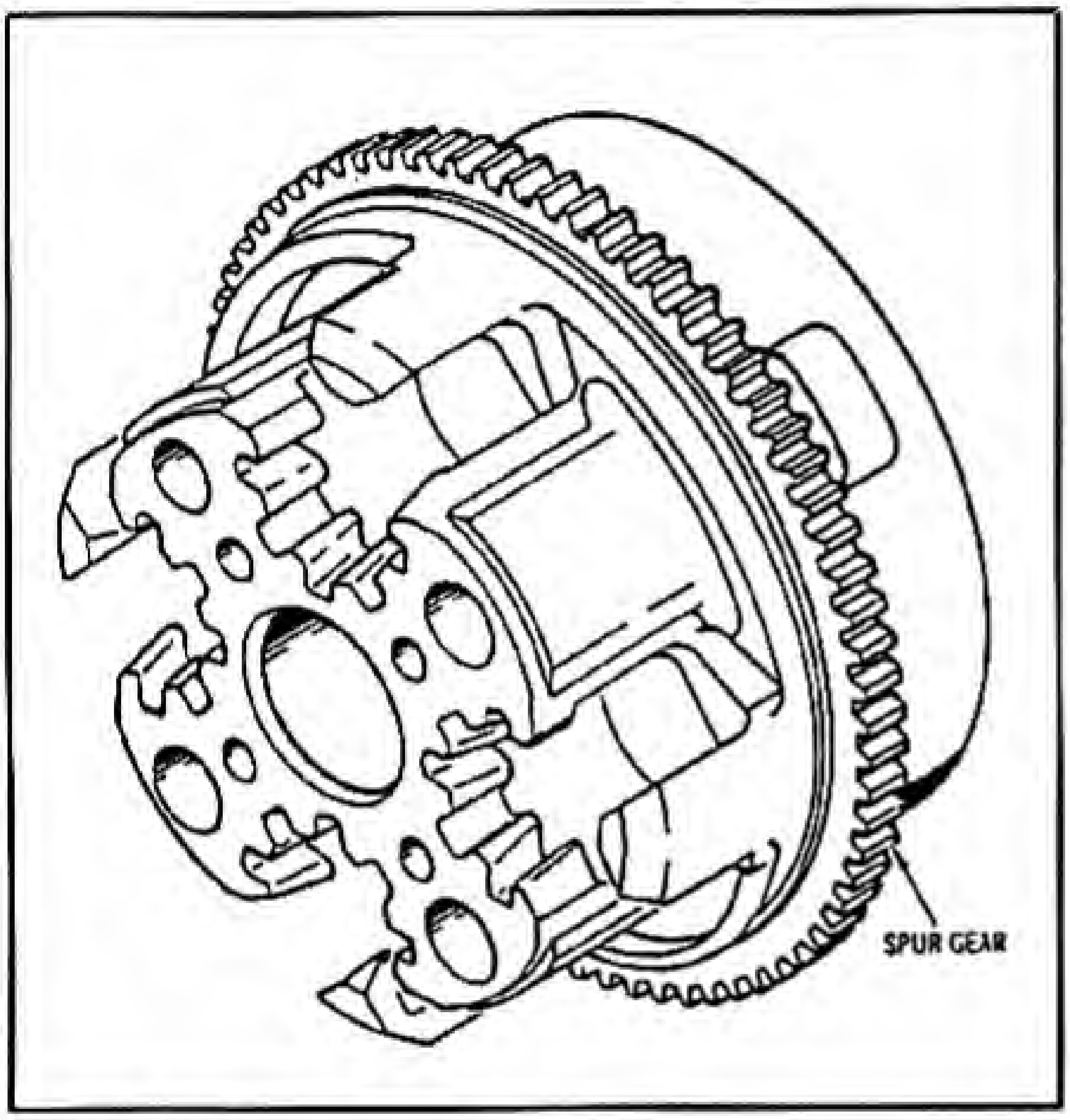
The forward rotor also contains breech lugs for locking the gun bolts to the rotor directly behind each barrel. The forward rotor is bolted to the rear rotor forming the rotor assembly. The main bearing is placed over the forward rotor and the rotor assembly can then be moved rearward into the gun housing. The rear housing is installed with a cover which, when bolted to the rotor, preloads both rotor bearings in the gun housing. The main forward bearing



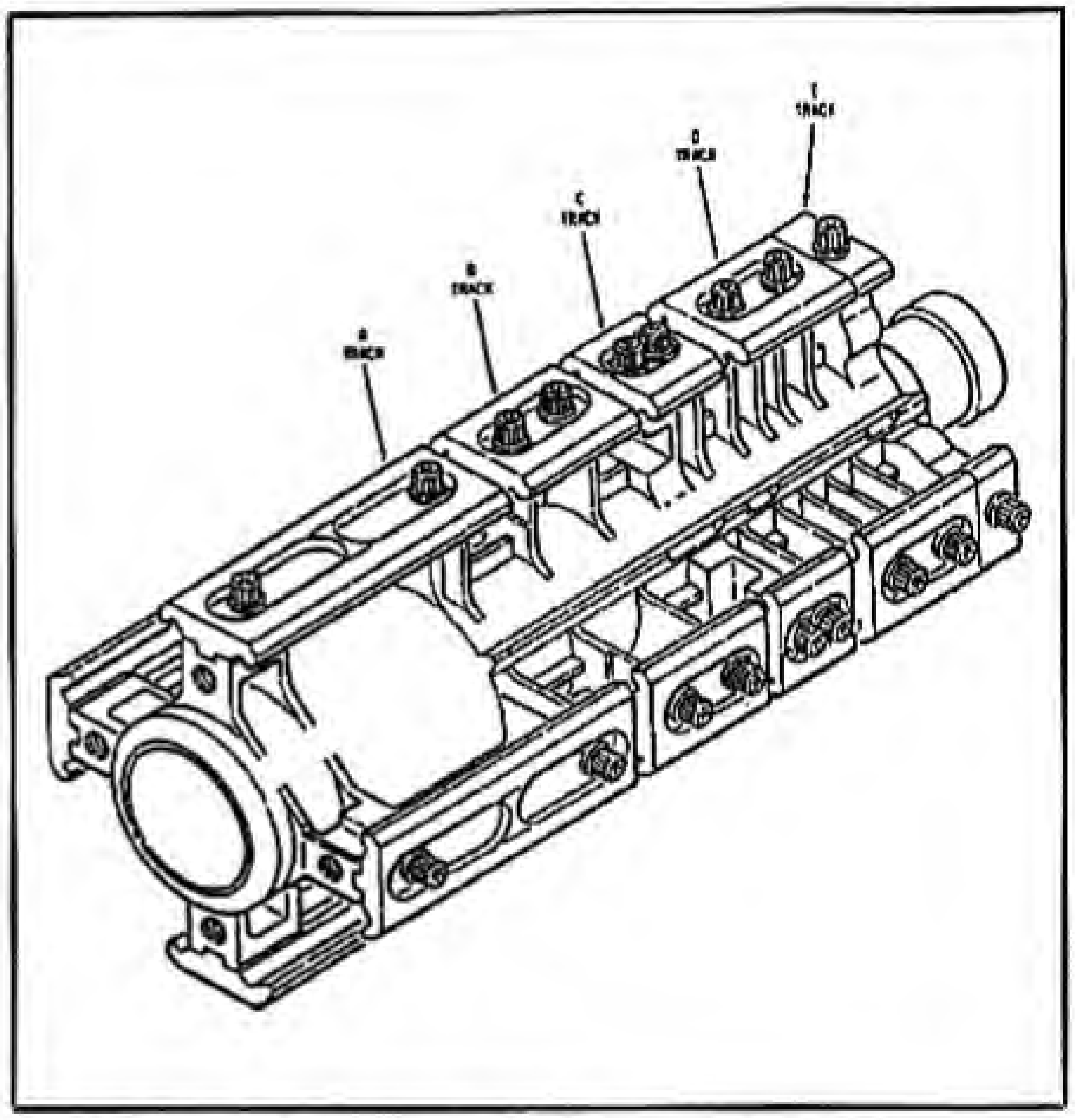
GAU-13/A 30mm Gun Group


LOCKING LUGS
BREECH ROTOR AREA
MID BARREL SUPPORT AREA
MUZZLE CLAMP AREA

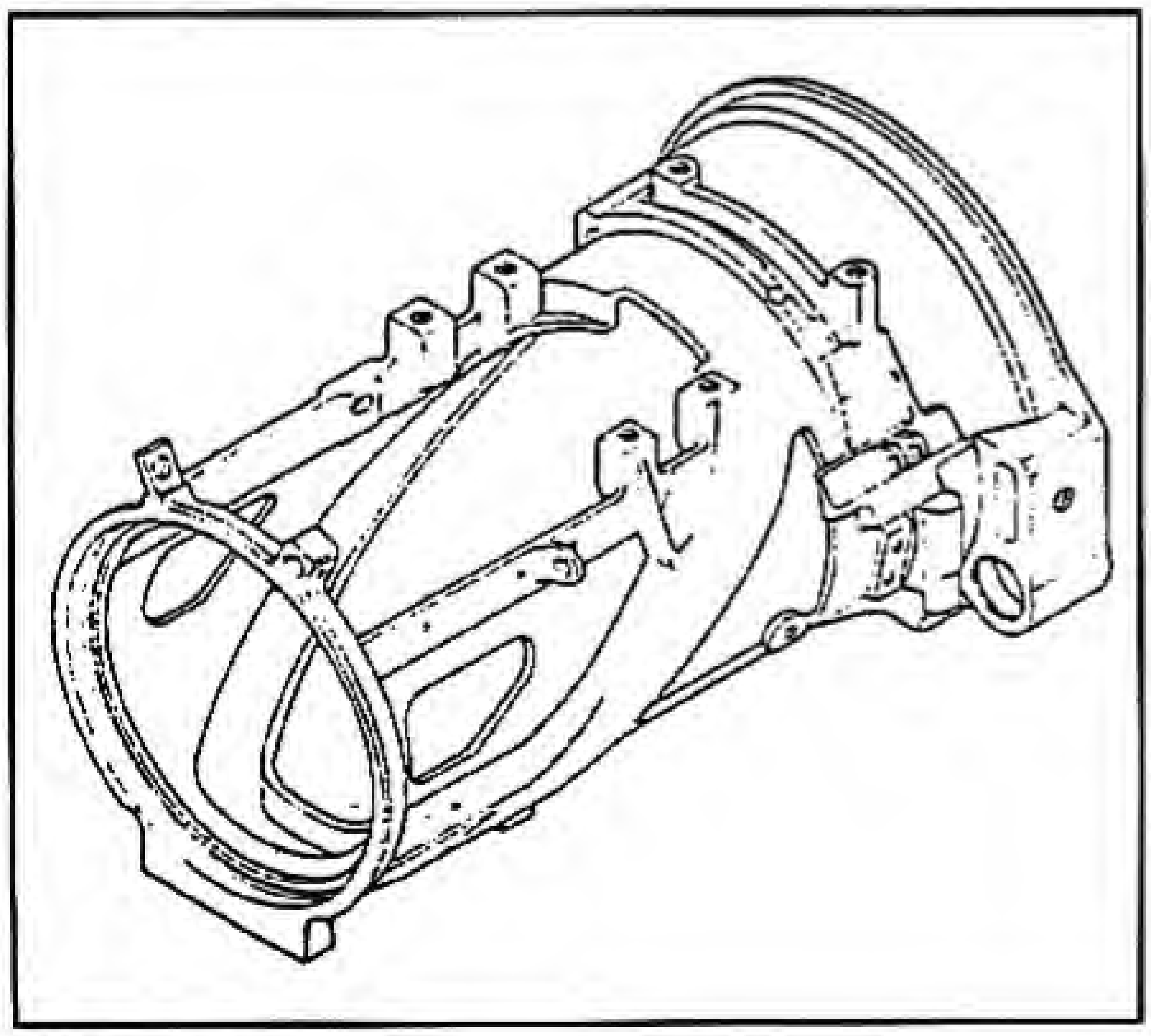
Barrel



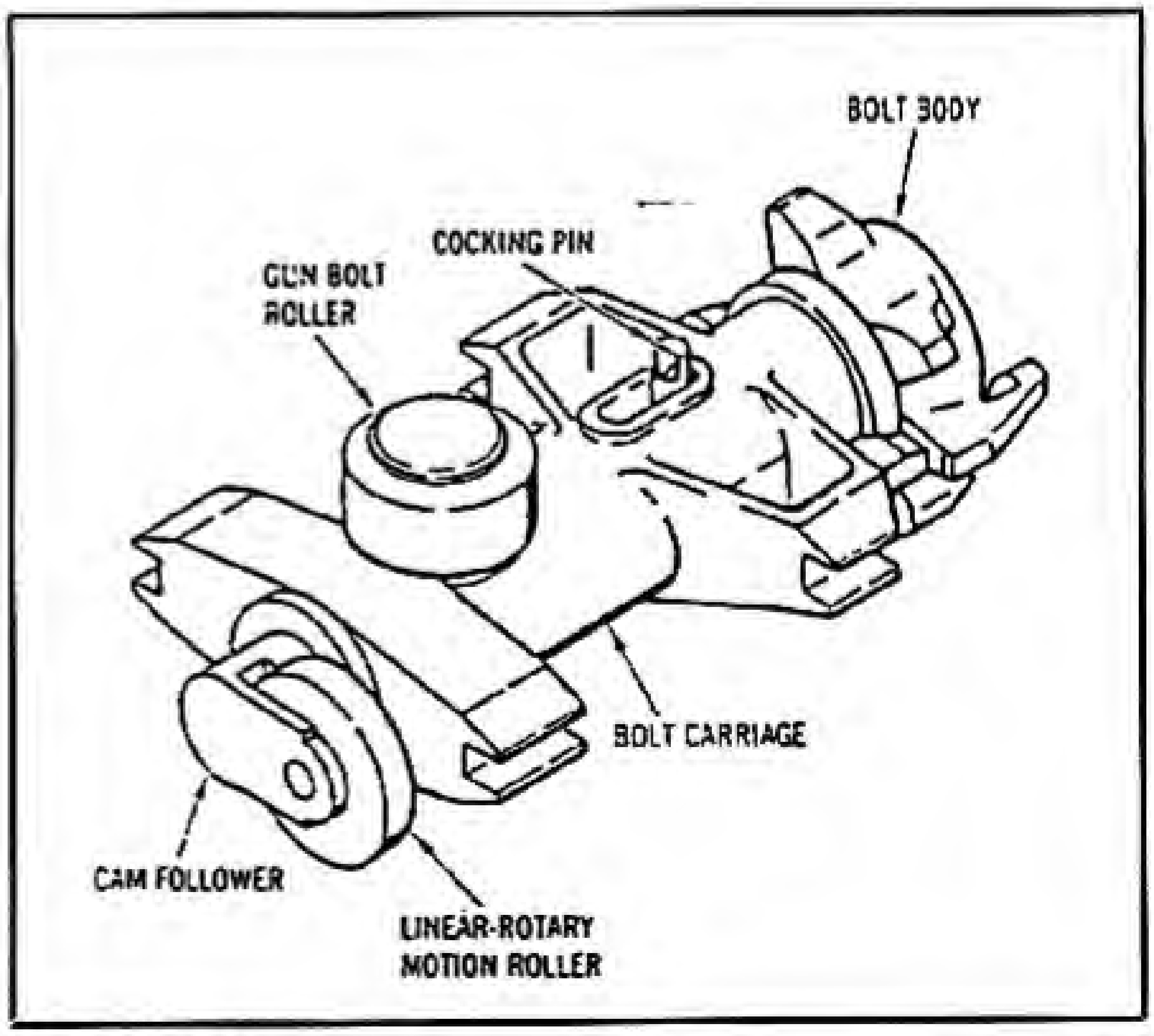
Breech Rotor


A TRACK
B TRACK
C TRACK
D TRACK
E TRACK

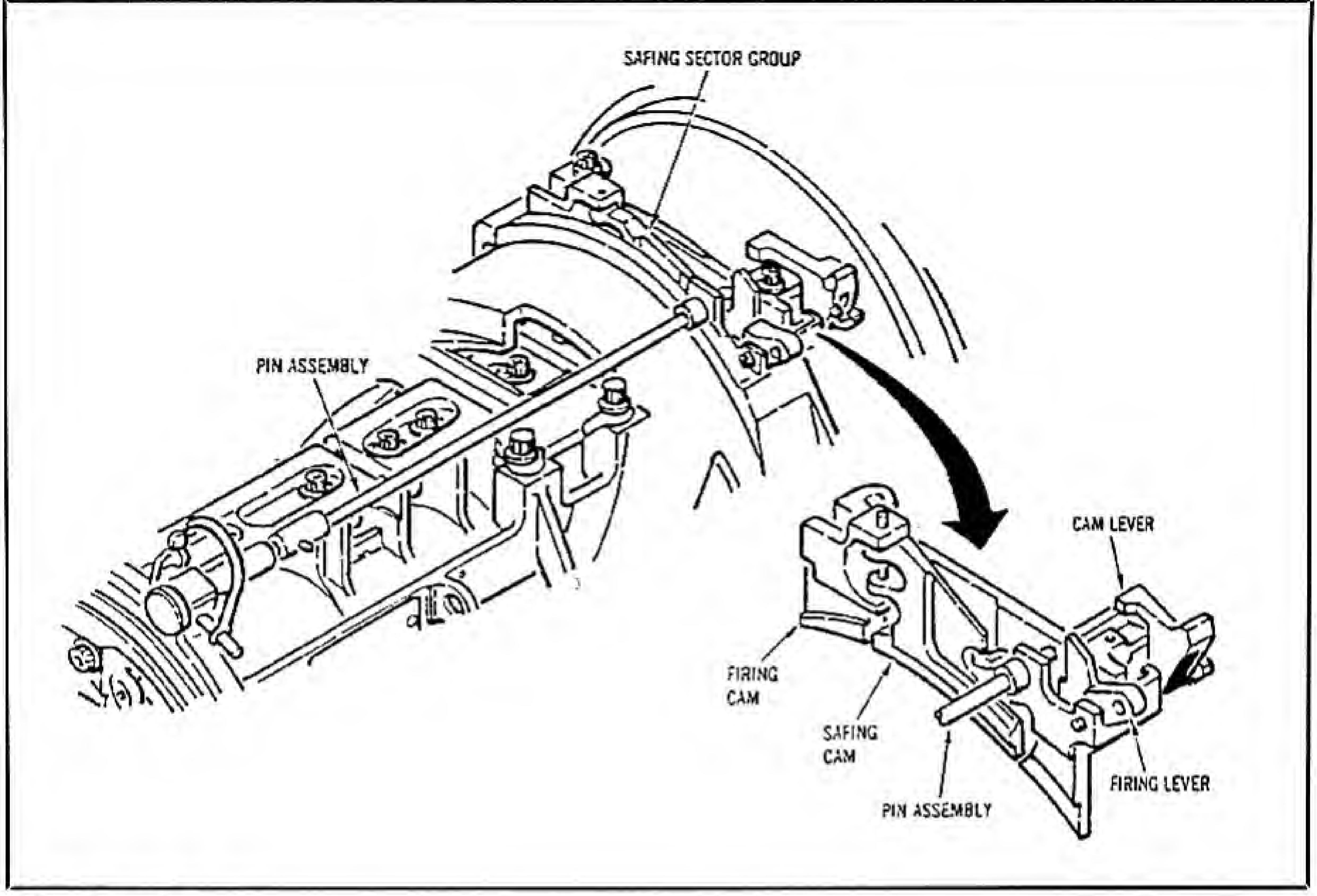
Track Rotor with Tracks Attached



Gun Housing


BOLT BODY
COCKING PIN
GUN BOLT ROLLER
BOLT CARRIAGE
CAM FOLLOWER
LINEAR-ROTARY MOTION ROLLER

Bolt Assembly



Safing Sector Group

transmits the firing load to the housing.

The gun housing contains the camway that controls the movement of the gun bolt assemblies during the rotation of the rotor assembly so that gun cycles of feed, ram, lock, fire, unlock, extract and eject are accomplished. The housing does not rotate. It is the fixed mounting frame for other gun components and assemblies including the guide bar, the transfer unit, the pneumatic drive pinion, the lock-unlocking cams and the safing sector.

There are four gun bolts in the gun. They rotate with the rotor and are driven fore-aft by the housing cam. Each gun bolt is locked to the breech by the rotation of bolt head, matching the lugs to those in the forward rotor. The firing pin is located inside the bolt. It is cocked against a spring by the safety and cocking cam while the gun bolt completes the ram stroke. It is seared off the cam as the head locks and fires the ammo.

After firing, the bolt head is rotated back by the lock-unlock cam and the bolt retracted. The fired case is extracted from the chamber by the bolt head and guided from the gun housing by the guide bar.

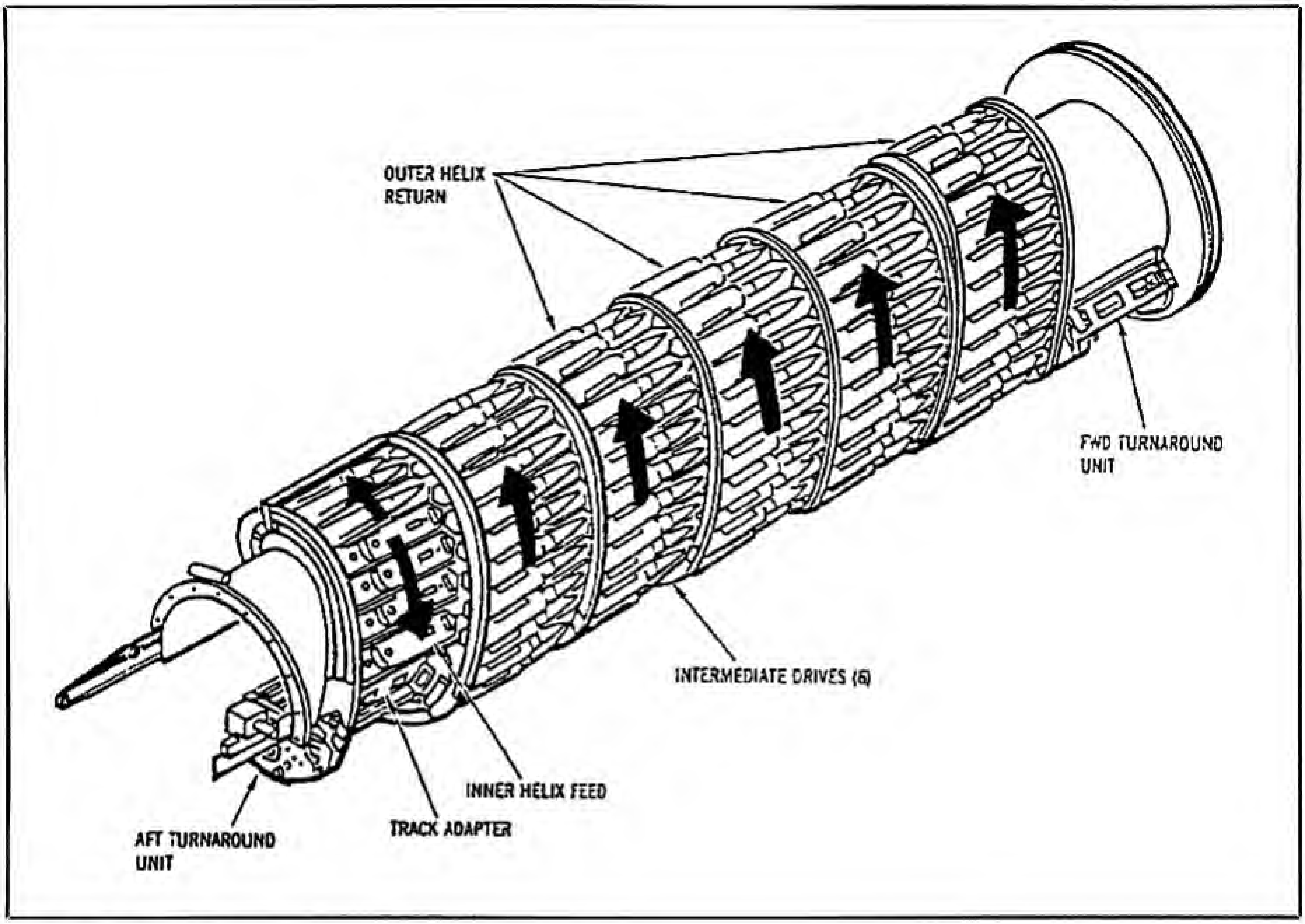
The safing sector (and cocking cam) can be pneumatically actuated to stop firing and safe the gun. It does this by preventing the firing pin from searing off the cam by closing the sear point. Also, during reverse clearing of the gun, the same sector lifts the firing pin over the sear. The recoil adapters are attached to the gun by linkage and to the pod by a yoke that transmits breech loads to the pod structure.

The transfer units bolts to the gun. It moves ammo from the conveyors to the gun bolt, and the cases back to the conveyor after firing.

Helixal Linkless Feed System

A new double-ended Helixal Linkless Feed System is used to feed the GAU-13/A 30mm gun when used in the GPU-5/A gun pod.

This Linkless Feed System is located under the skin of the gun pod and forms a helix running fore-aft


OUTER HELIX RETURN
FWD TURNAROUND UNIT
INTERMEDIATE DRIVES (6)
INNER HELIX FEED
TRACK ADAPTER
AFT TURNAROUND UNIT

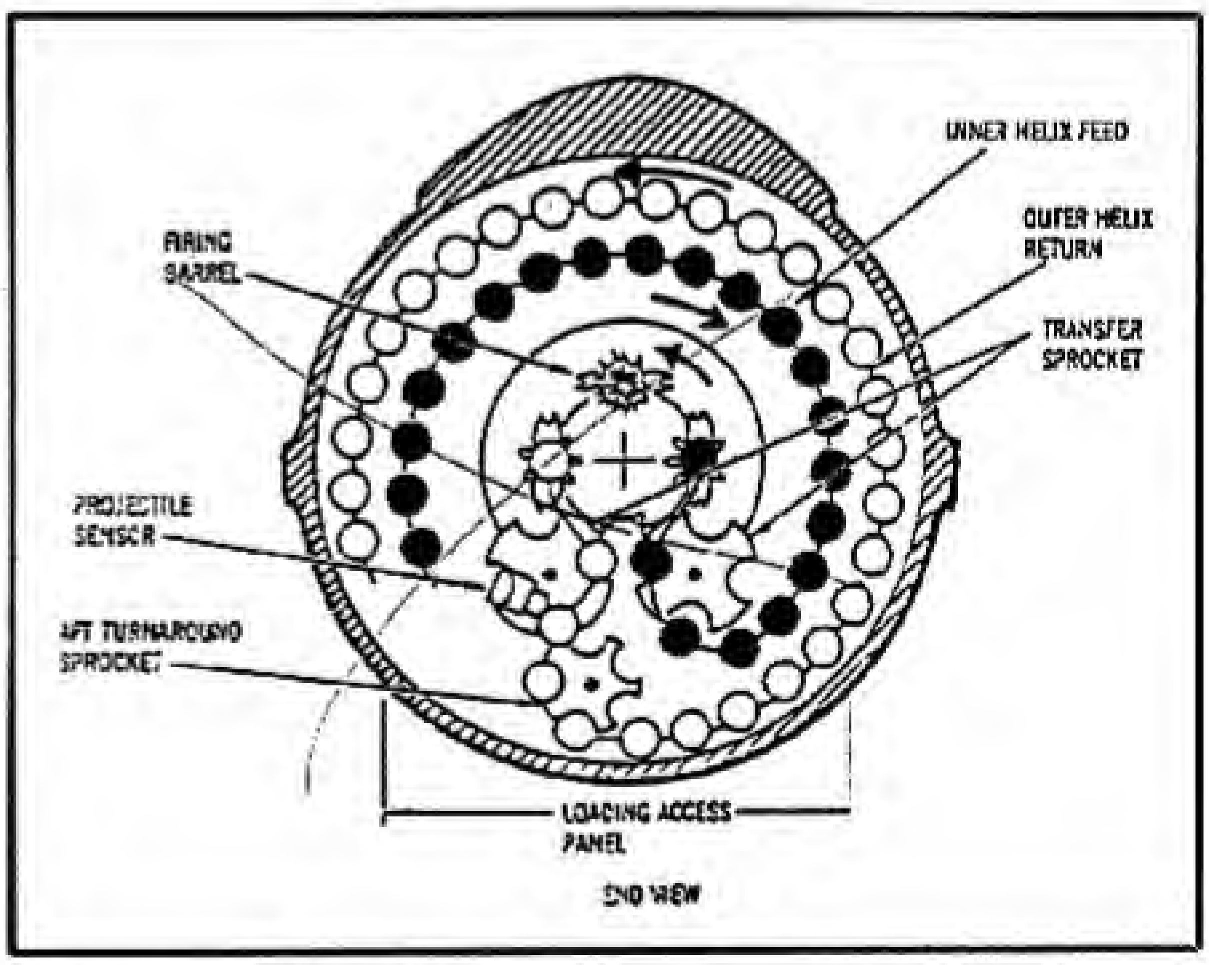
Feed and Storage Functional Diagram

over the gun. There is a tube between the gun and the helix.

The helix is an actual double-layer helix of ammunition carriers that are linked to each other at both the ammo base and projectile ends forming a continuous loop of ammunition. The double layer helix is constructed by fixed partitions fastened to the tube forming a continuous helical shape from the rear of the gun to the muzzles. At both the rear and muzzle ends, turnaround units are located.

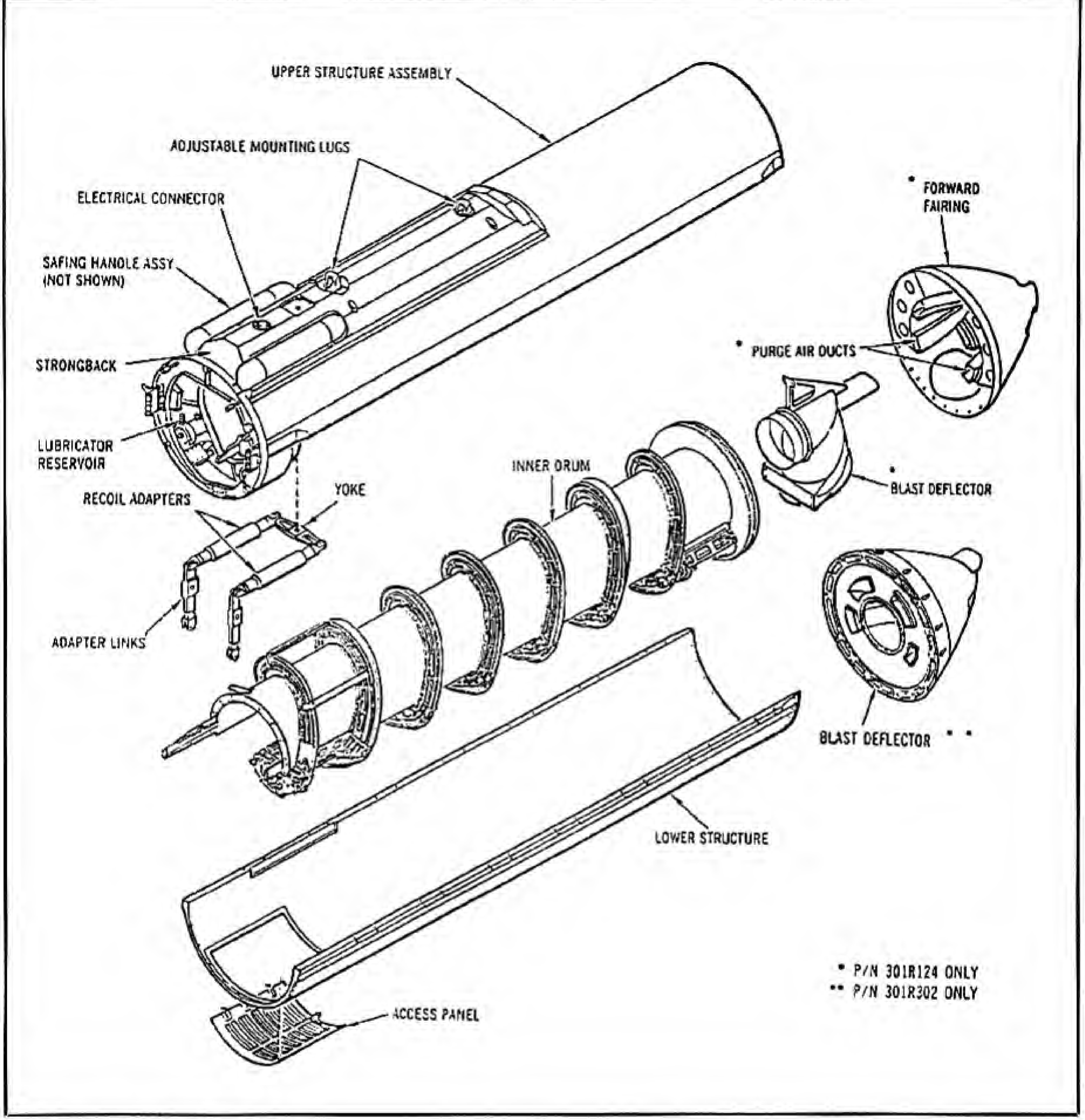
The partitions have two tracks—one outer and one inner. The ammo carriers have a roller at each end that runs in the tracks.

By fastening the carriers together and placing them in the helixal trackways, both inner and outer, two belts of carriers are formed. By fastening each belt together at the turnarounds, a continuous belt is formed. The belt can be moved by shafts and sprockets along the stationary partitions. The carriers on the outside trackway running forward (when firing) and those on the inside running rearward.


INNER HELIX FEED
OUTER HELIX RETURN
FIRING BARREL
TRANSFER SPROCKET
PROJECTILE SENSOR
AFT TURNAROUND SPROCKET
LOADING ACCESS PANEL
END VIEW

Ammunition Flow Diagram

The inner helix of carriers bring ammo to the gun via the transfer unit attached to the gun which

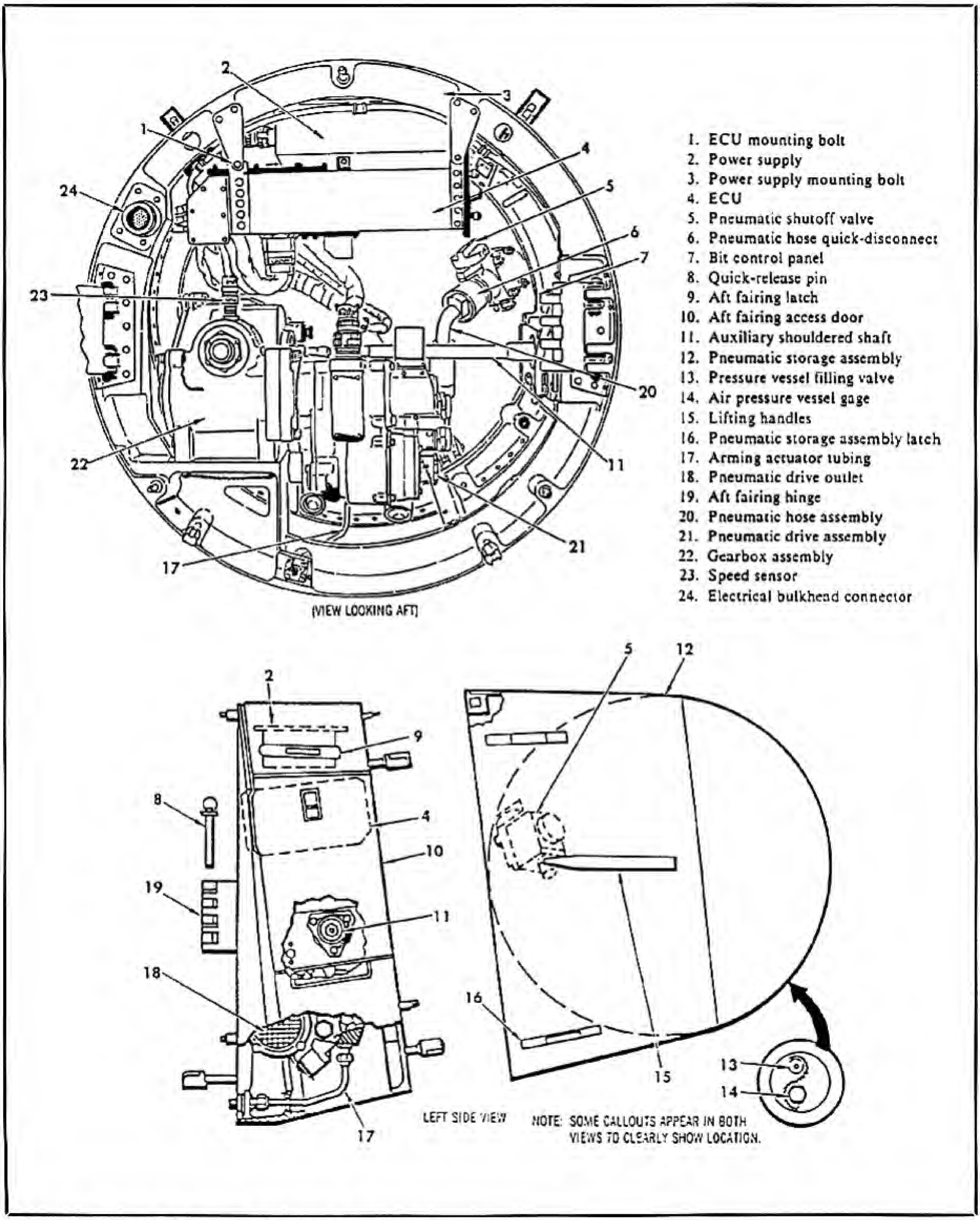

UPPER STRUCTURE ASSEMBLY
ADJUSTABLE MOUNTING LUGS
ELECTRICAL CONNECTOR
SAFING HANDLE ASSY (NOT SHOWN)
STRONGBACK
LUBRICATOR RESERVOIR
RECOIL ADAPTERS
YOKE
ADAPTER LINKS
INNER DRUM
* FORWARD FAIRING
* PURGE AIR DUCTS
* BLAST DEFLECTOR
BLAST DEFLECTOR * *
LOWER STRUCTURE
ACCESS PANEL
* P/N 301R124 ONLY
** P/N 301R302 ONLY

Pod Assembly Group Components

removes ammo, one at a time, from the carriers and through the guide bar places them into the gun bolts for firing. After firing, the empty cases are passed through the guide bar ejection side back into the transfer unit and hence into the empty carriers.

The carriers run around the aft turnaround, enter the outer partition trackway and travel forward on the outer helix. They enter the forward turnaround and return aft by traveling in the inner partition trackway.

This system carries 350 rounds of ammo and is loaded at the aft turnaround. All the carriers reverse direction during reverse gun clearing.



1. ECU mounting bolt
2. Power supply
3. Power supply mounting bolt
4. ECU
5. Pneumatic shutoff valve
6. Pneumatic hose quick-disconnect
7. Bit control panel
8. Quick-release pin
9. Aft fairing latch
10. Aft fairing access door
11. Auxiliary shouldered shaft
12. Pneumatic storage assembly
13. Pressure vessel filling valve
14. Air pressure vessel gage
15. Lifting handles
16. Pneumatic storage assembly latch
17. Arming actuator tubing
18. Pneumatic drive outlet
19. Aft fairing hinge
20. Pneumatic hose assembly
21. Pneumatic drive assembly
22. Gearbox assembly
23. Speed sensor
24. Electrical bulkhead connector

NOTE: SOME CALLOUTS APPEAR IN BOTH VIEWS TO CLEARLY SHOW LOCATION.

Pneumatic Storage/Aft Fairing Assembly Component

Pneumatic Drive for the GAU-13/A Gun and the GPU-5/A Pod

The pneumatic drive assembly in the aft fairing assembly consists of the following components: pressure control assembly, turbine motor and control assembly. The pressure control assembly consists of a low pressure switch, a pressure transducer port, a pressure regulator, and an electrically controlled shutoff valve. The pressure control assembly regulates the pressure supplied to the motor and control assembly when electrically switched on.

The motor and control assembly consists of the pneumatic drive motor and the control system. The pneumatic drive motor (regulated by the control system) powers the gearbox which, in turn, drives the gun system. The control system receives electrical input signals to provide the following operations:

a. Release the brake

b. Accelerate and control gun system speed

c. Stop the gun system

d. Reverse the gun system

e. Control the pneumatic actuator on the safety cam.

The drive motor is a reversible turbine capable of generating 60 HP at 9000 rpm. Air is stored in a reinforced vessel at 3000 psi which is sufficient for firing two complements of ammo.

Installation of the GAU-13/A in the GPU-5/A Pod

The GPU-5/A gun pod provides a variety of fighter and attack aircraft with the capability of engaging armed or amphibious assault vehicles, inflicting destructive bursts of fire from extended ranges using the GAU-8/A developed ammunition. The pod has lightweight and self-contained power which enables it to be installed on the wing or centerline stations of a variety of tactical aircraft, including the A-4, A-7, F-4, F-5, F-15, F-16, F-18, F-20 and A-10. The GPU-5/A 30mm gun pod thus provides an effective, flexible means of increasing fire power for these aircraft.

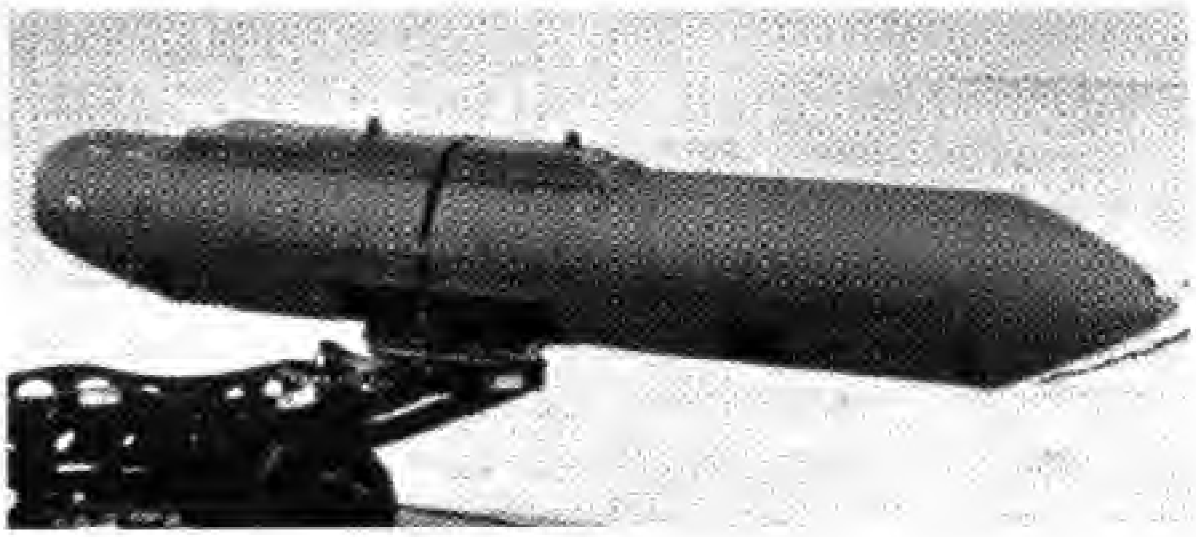
Characteristics

Type	Externally powered, lightweight Four Barrel Gatling, 30mm
Length	110 in.
Max. Diameter	12 in.
Weight	339 lbs.
Power to Drive	22 HP
Rounds to First Scheduled Maintenance	15,000 rds (42 Full Complements on GPU-5/A)
Reliability	32,000 MRBF
Ammunition	GAU-8/A (TP, HEI, API) Muzzle Velocity 3400 ft/sec. HEI 3240 ft/sec. API
Dispersion (80% of rounds fired)	6 mil
Rate of Fire	2400 spm
Time to Rate	0.3 second
Recoil Force:	
Peak (max.)	12,000 lbs.
Peak (recurrent)	10,000 lbs.
Average @ 2400 spm	5,400 lbs.
Recoil Travel* (max.)	1.20 in.
Drive Type*	Pneumatic
Feed System	Linkless
Clearing by	Gun Reversal

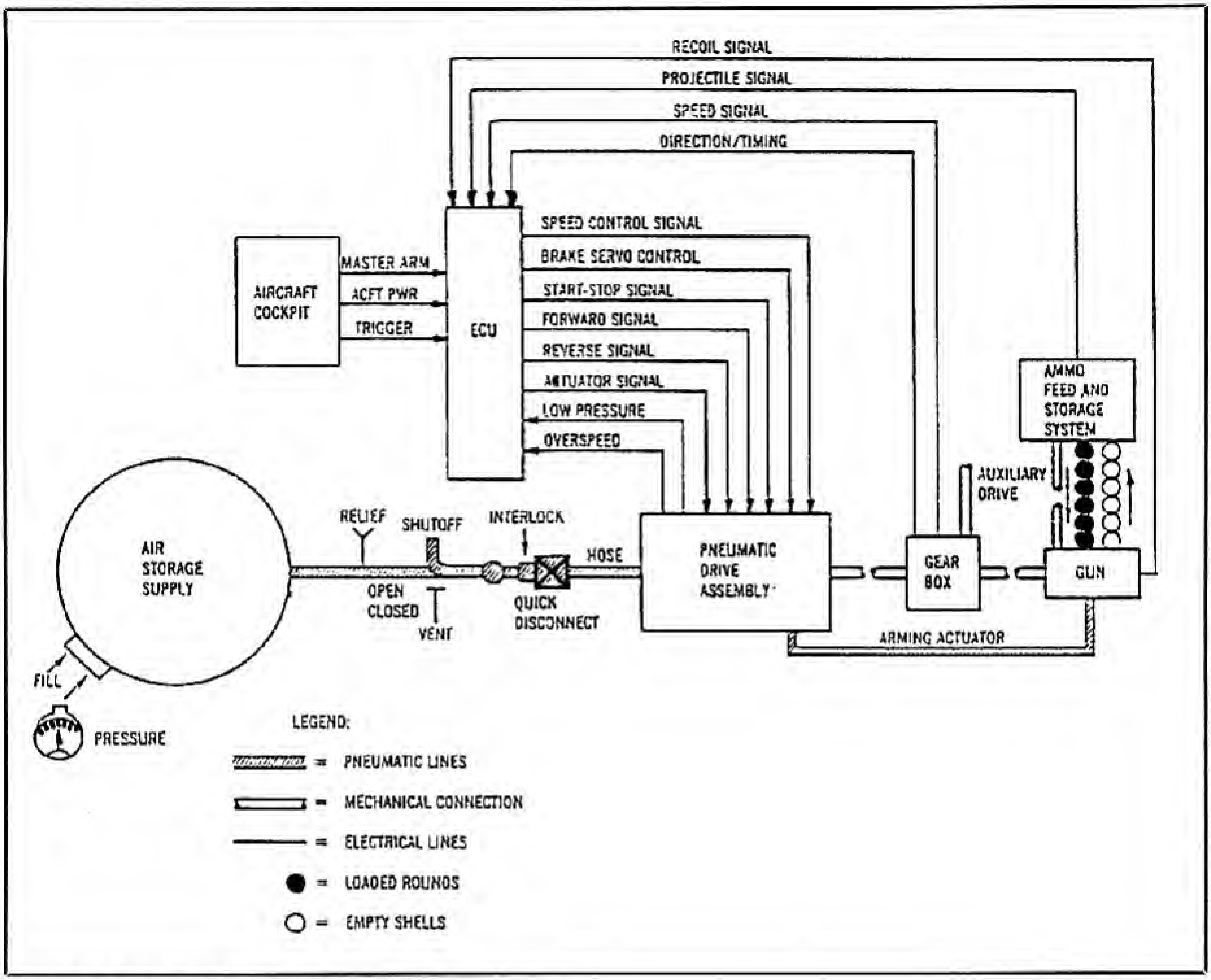
*Typical GPU-5/A Installation: Drive Type, Recoil Forces, etc. can be tailored to individual gun installation.

Operation of the GPU-5/A 30mm gun pod requires 28 volt DC or 115V, 400HZ AC aircraft power signal and two aircraft control signals. The two aircraft control signals are the master arm signal and the trigger signal. When the aircraft master arm switch is placed to ON, the shutoff valve is open, and the firing trigger is depressed, the GPU-5/A system is

F-15 with GPU-5/A Pod



GPU-5/A 30mm Gun Pod


RECOIL SIGNAL
PROJECTILE SIGNAL
SPEED SIGNAL
DIRECTION/TIMING
AIRCRAFT COCKPIT
MASTER ARM
ACFT PWR
TRIGGER
ECU
SPEED CONTROL SIGNAL
BRAKE SERVO CONTROL
START-STOP SIGNAL
FORWARD SIGNAL
REVERSE SIGNAL
ACTUATOR SIGNAL
LOW PRESSURE
OVERSPEED
AMMO FEED AND STORAGE SYSTEM
AUXILIARY DRIVE
AIR STORAGE SUPPLY
RELIEF
SHUTOFF
INTERLOCK
HOSE
OPEN
CLOSED
VENT
QUICK DISCONNECT
PNEUMATIC DRIVE ASSEMBLY
GEAR BOX
GUN
ARMING ACTUATOR
FILL
PRESSURE
LEGEND:
▨ = PNEUMATIC LINES
= MECHANICAL CONNECTION
= ELECTRICAL LINES
● = LOADED ROUNDS
○ = EMPTY SHELLS

GPU-5/A Basic Block Diagram

placed in operation. Air, stored in the pressure-vessel of the pneumatic storage assembly, is released by the pressure control assembly. The pneumatic drive assembly drives the gun and the ammunition feed and storage system.

The system is controlled by signals supplied from the Electronic Control Unit (ECU). The ECU is a small metal box located in the aft section. It controls gun firing and clearing sequences, the quick reapplication of the trigger signal and gun safing, the reverse clearing. If the low pressure signal or an ammunition limit signal is sensed, the ECU will not supply the start signal to open the air supply needed to drive the pneumatic drive assembly.

The release of the gun trigger directs the ECU to remove the safing cam arming actuator signal which engages the gun safing cam and prevents firing. The ECU also removes the forward rotation signal supplied to the pneumatic drive assembly but due to the high gun rotation speed, several rounds pass through the gun and back into the ammunition feed and storage system before the brake can actually halt the gun. The ECU then supplies a reverse rotation signal to cycle the rounds back through the gun and into the feed side. When all rounds have been cycled back through the gun (as detected by the projectile sensor located in the transfer unit), the brake is again applied which stops the reverse gun rotation. The gun system is now stopped, cleared, and in position to start firing again.

Ammunition

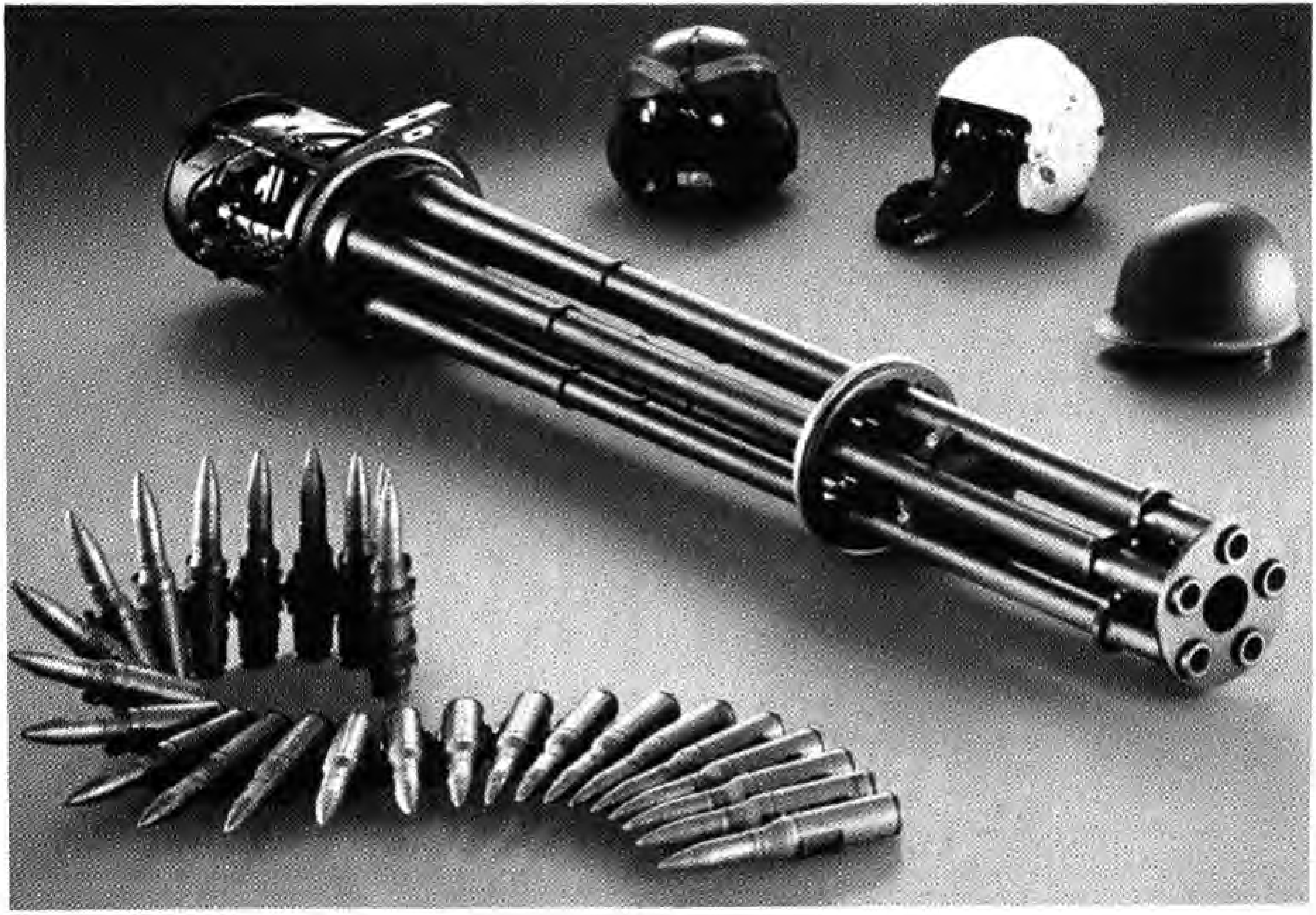
The GAU-13/A exhibits identical ballistic properties (muzzle velocity, range, etc.) to that of the GAU-8/A. Comprised of a Target Practice (TP), High Explosive Incendiary (API) round, this ammunition uses an aluminum cartridge case to reduce ammunition weight and plastic rotating bands to extend gun barrel life.

This 30mm ammunition offers unique capabilities not available with 20mm or the Aden 30mm round, including an increase of four times the kinetic energy at twice the range.

Chapter 14

25mm GAU-12/U EQUALIZER GUN

GENERAL ELECTRIC



25mm GAU-12/U Equalizer Gun

Introduction

The five barrel Equalizer Gun was designed to fire the 25mm Bushmaster family of ammunition to defeat hard ground targets in close-in-air-support by the U.S. Marines Harrier AV-8B vertical take-off aircraft.

The Equalizer GAU-12/U Gun is of Gatling-Vulcan vintage and more closely resembles in detail design a more recent predecessor, the 30mm Avenger. The fundamental principle of operation is that of a rotary gun where five barrels form a rotating cluster and one barrel fires at a time in a very rapid succession for high firing rates.

However, the gun bolt assemblies use a rotary bolt

AV-8 Harrier Armament System

head breech lock like the Avenger. It also uses the Avenger scheme of firing pin control and of back-up reverse gun clearing at the end of each burst.

On the other hand, the Equalizer is just a little heavier and a little longer than the old trusty 20mm Vulcan M61A1. The firing rate is 3600 shots per minute but the ammunition has a significantly greater muzzle velocity and terminal effect than the 20mm M50 family of ammunition.

History

The Equalizer GAU-12/U 25mm gun is used on the Harrier AV-8B aircraft made by McDonnell-Douglas for the U.S. Marines.

One of the prime reasons for the Equalizer being on the Harrier reverts back to the time when the Marines were operating their first Harriers AV-8A's on-board Navy carriers. The AV-8A had revolver guns, the Aden/Defa 30mm. They had an unsolvable problem in that the guns could not be safed against cook-off or Radhaz effects.

The Equalizer happened to be available, almost. It was in preliminary desity study, until in April 1978 and Independent Research and Development Project was opened by General Electric for a lightweight proven design, Vulcan-type gun to fire the more effective Bushmaster ammunition. The Equalizer fired its first shots in December 1978.

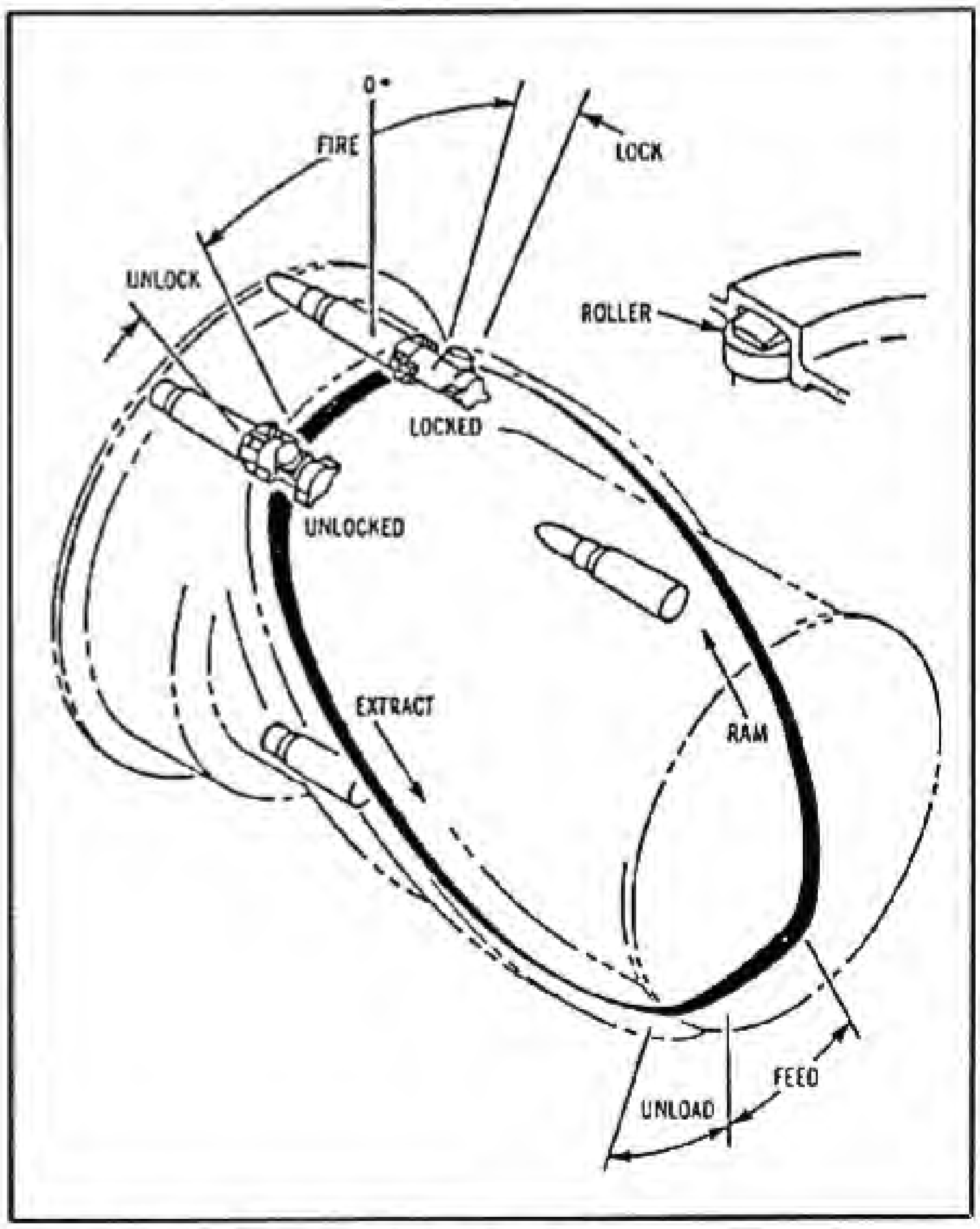
It was demonstrated to the U.S. Navy at China Lake NAS in February 1979. A little over a year later, in July 1980, the first prototype system was installed in a Harrier and flight-fire tested. Flight tests continued at Pax River, NAS and China Lake, NAS for the remainder of 1980 into early 1981.

In June 1981, the U.S. Navy contracted General Electric for the first production quantities of the Equalizer GAU-12/U, 25mm armament systems.

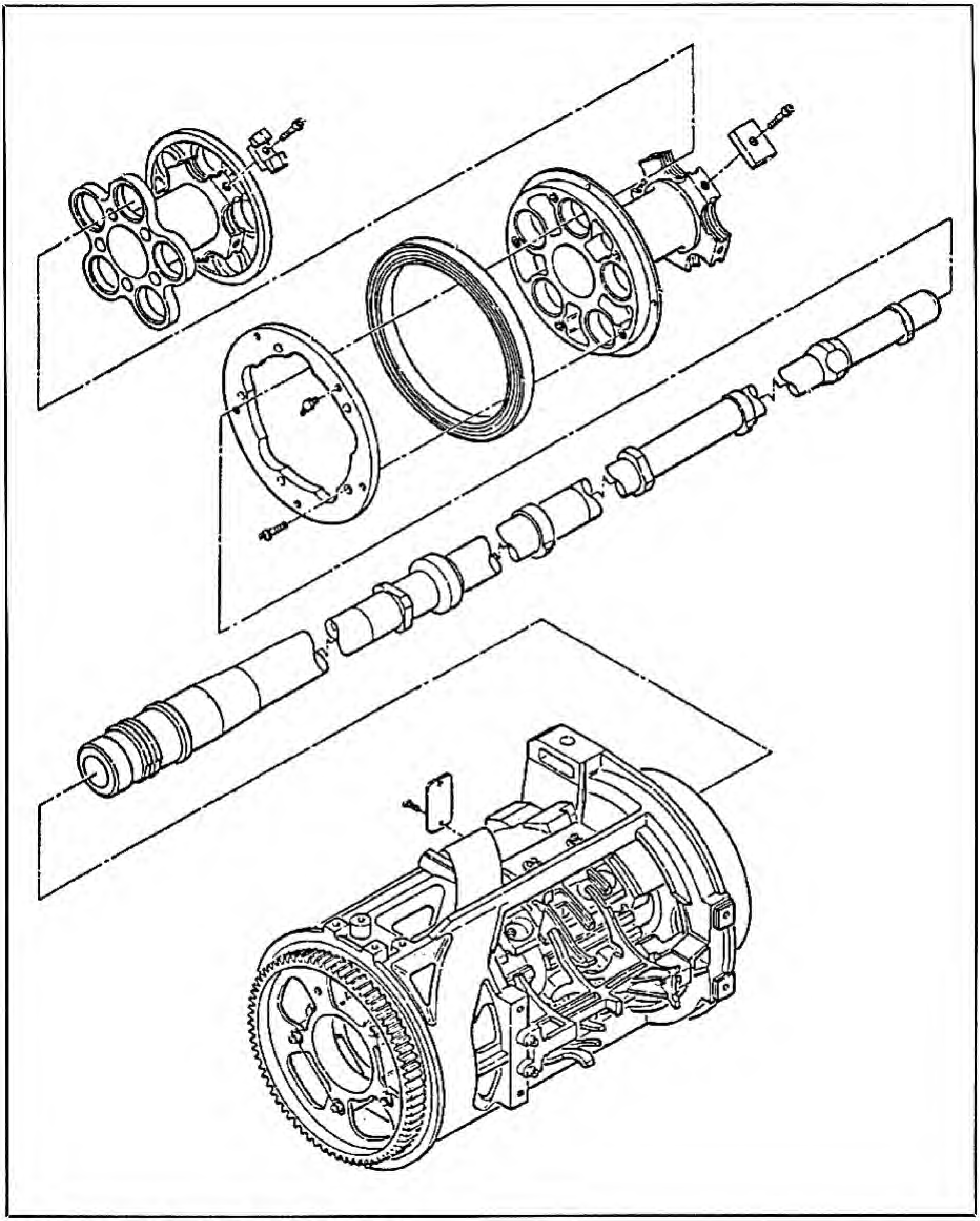
Sixty systems have been produced up to mid 1986, and production is continuing at this time.

Equalizer Operation

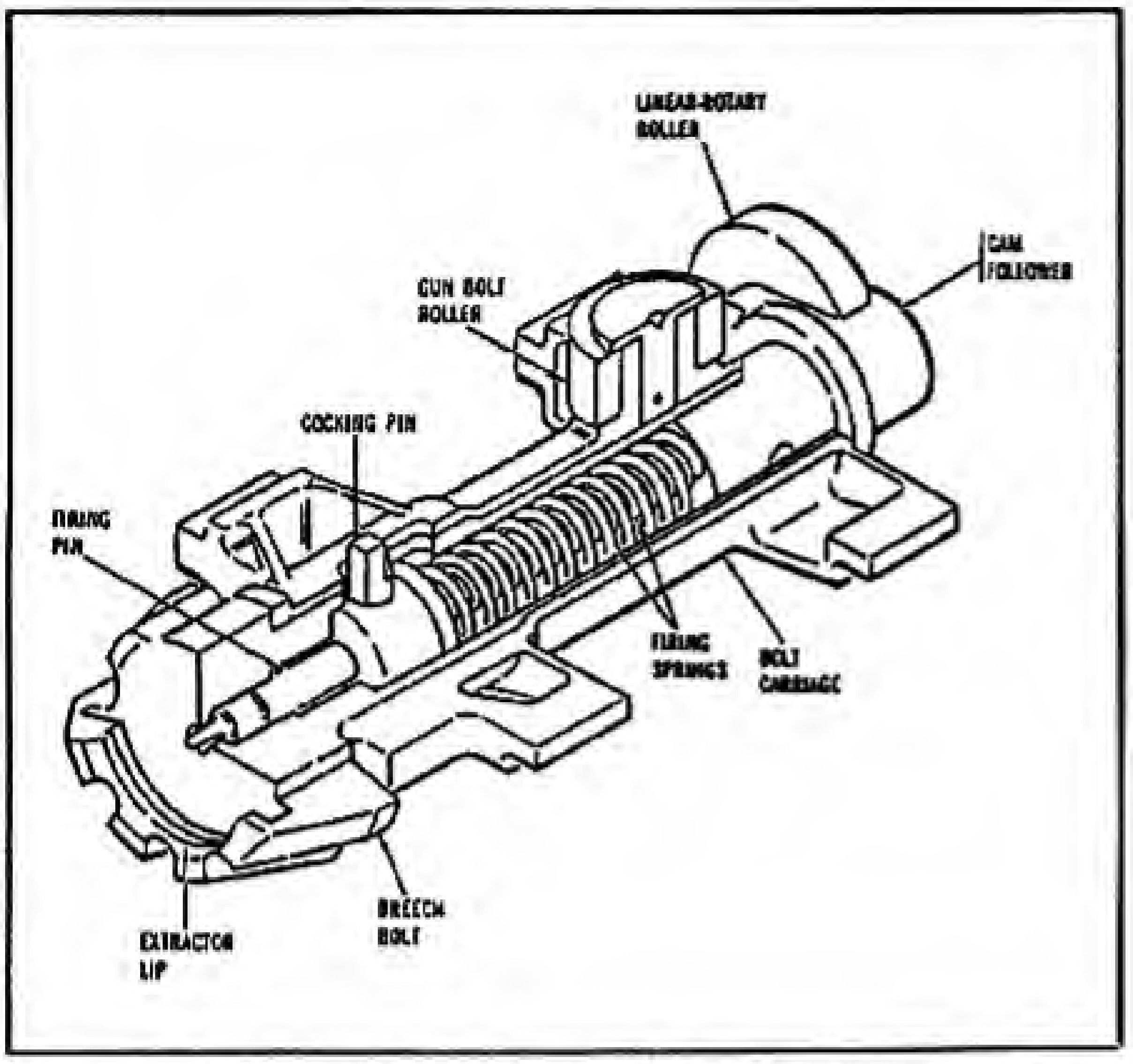
Firing Cycle. The Equalizer Gun operates the same



Firing Cycle Showing Breech Bolt Motion



GAU-12/U 25mm Automatic Gun (Exploded View)



Breech Bolt Assembly in Uncocked Position (Cutaway View)

way as the Vulcan 20mm, the Minigun 7.62mm and the Avenger 30mm guns. They all function (with jet-age designs and materials) as Richard J. Gatling's guns did when he patented his in 1862.

These guns have multiplicity of barrels that are held together in a circular pattern. This group of barrels rotate about their common axis, and fire one round at a time as each barrel is rotated past a fixed firing position on the non-rotating gun housing.

The cluster of barrels can be driven up to 1000 revolutions per minute by electric, hydraulic or pneumatic external drives. If there are five barrels in the Equalizer cluster and each barrel fires once per revolution of the cluster, then the firing rate of the combined gun is 5000 shots per minute.

Gun Bolts. The Equalizer has a gun bolt behind each barrel that turns with the rotor as the barrel cluster rotates. The gun bolts are driven from the rear of the gun by an elliptical cam in the gun housing where they pick up a new round of ammo. This cam drives the gun bolts into battery where they are locked and fired; and, after unlocking, to the rear of the gun again where the extracted spent case is ejected from the gun.

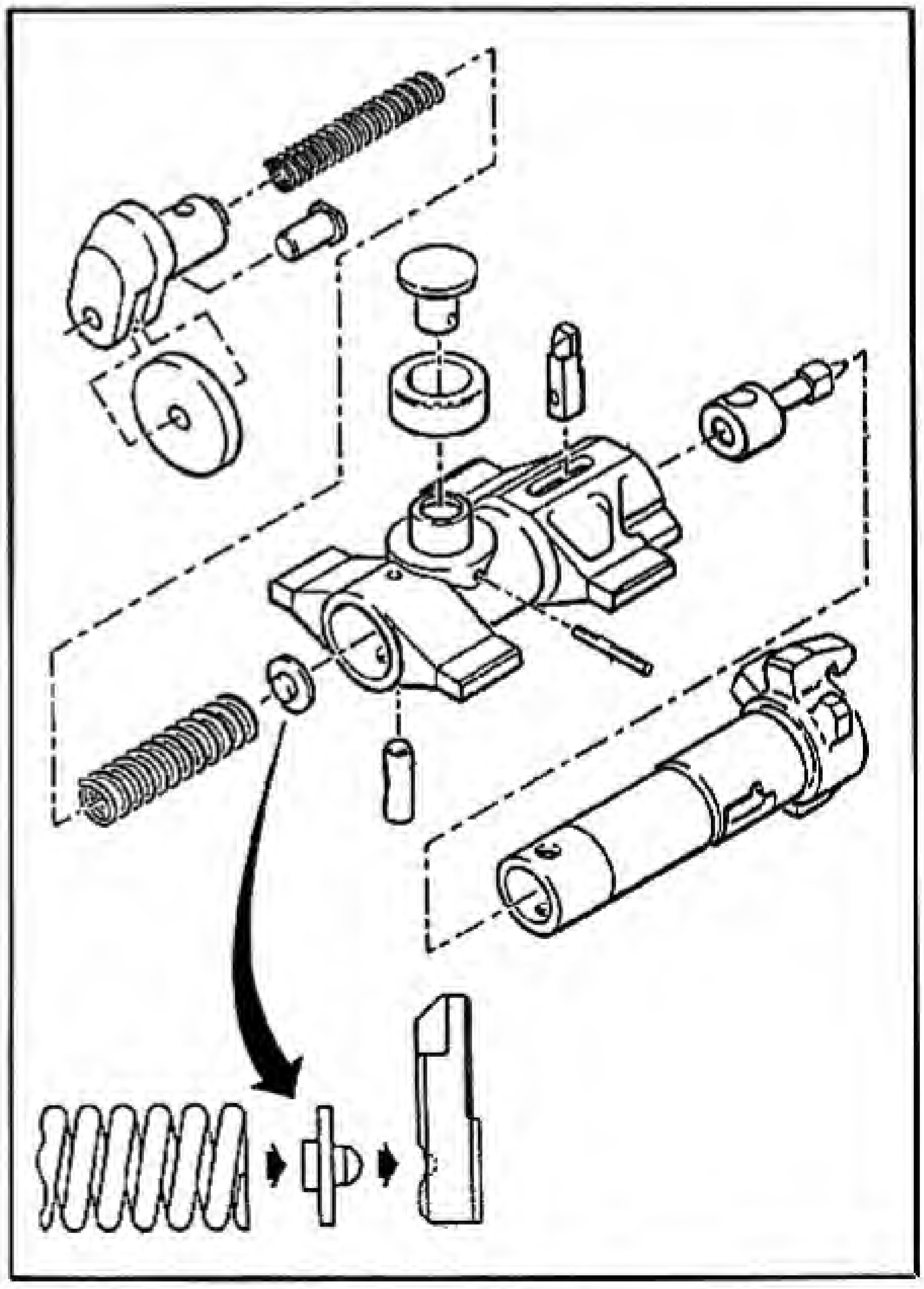
Lock and Unlock Cam. A cam is bolted to the gun housing at the 50° firing sector and located behind the front dwell of the main cam. The gun bolts are locked by this cam after the bolt has fully chambered a new cartridge in the barrel. The cam is merely a smooth path on which the bolt locking roller rides. This path forces the roller up and creates a torque on the bolt head shaft that rotates it into a locked position.

After firing, the cam path forces the roller down and a reversing torque rotates the bolt head back to the unlock position. Case extraction immediately follows.

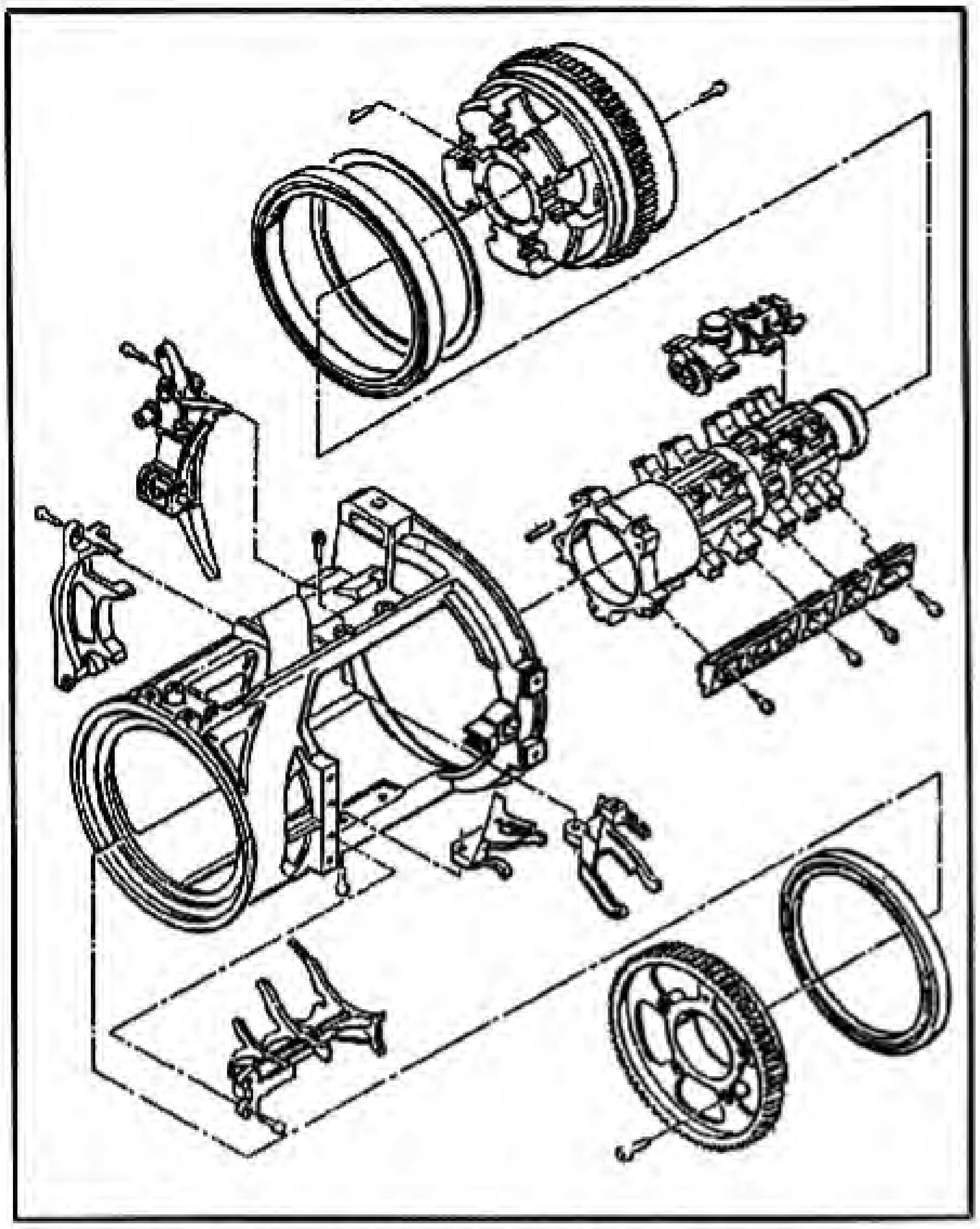
Safing and Cocking Cam. A fairly complex cam assembly controls the firing pin. It is bolted to the gun housing at the 50° firing sector.

The cocking pin on the firing pin makes contact with this cam slightly before chambering is completed. The cocking pin is held back as the gun bolt completes chambering, cocking the firing pin springs.

As soon as lock is achieved, the cocking pin is seared off the cam, firing the round. To stop firing and to reverse clear the gun, a sector is placed at the sear point so that the cocking pin cannot be seared off. This sector also lifts the cocking pin over the sear point during reverse gun rotation for clearing the gun.



Breech Bolt Assembly (Exploded View)



25mm Gun Subassembly (Exploded View)

Gun Bolt Description

The design and operation of the Equalizer's gun bolts are the same as those of the 30mm Avenger's gun bolts.

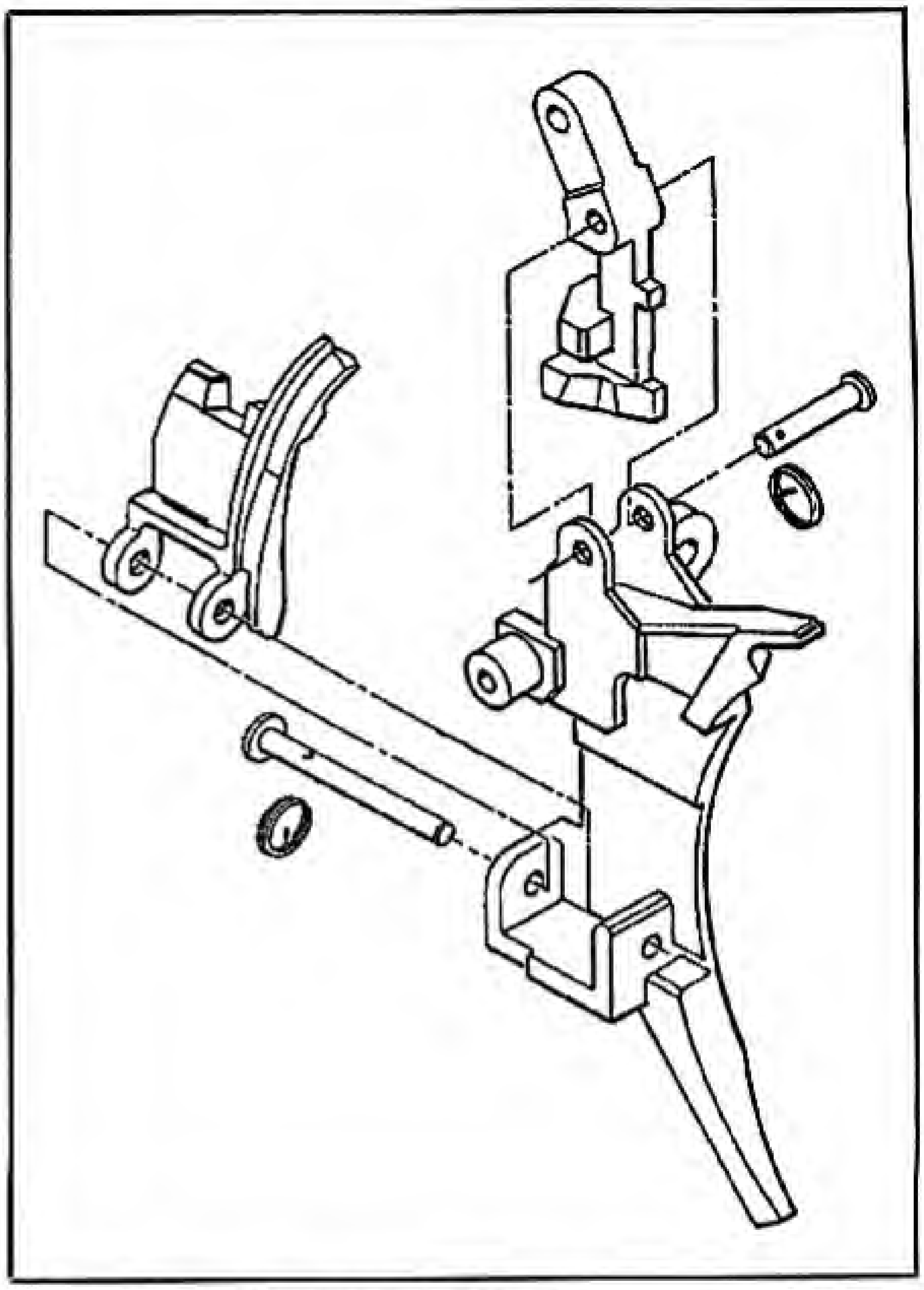
The rotating bolt head is used to lock the breech during firing. The head is rotated by a single large roller which is slightly different than the Avenger which uses two small rollers. The roller is pushed up by the lock cam to lock the head and pushed down to unlock it.

The firing pin actuation is the same as Avenger except two springs are used due to the space limitations in the smaller Equalizer gun bolt.

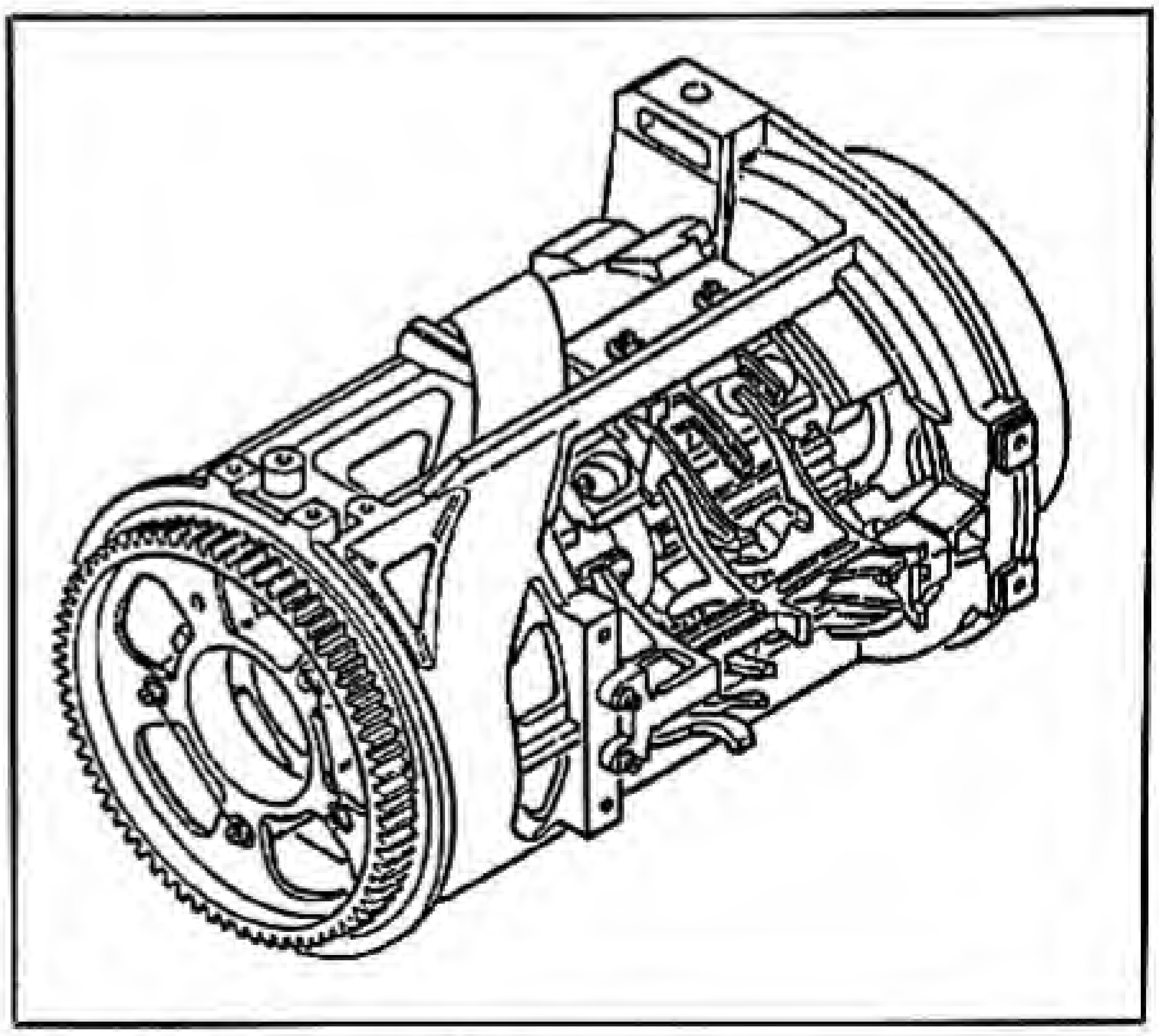
Description of Major Gun Components

The revolving components are the rotor and the barrel cluster while the non-revolving parts are the gun housing itself and other parts that are fastened to it.

Rotor. The rotor is of a two-piece construction. The forward rotor containing the breech locking elements, is bolted to the rear rotor which contains provisions for the gun bolts to rotate with the rotor and to translate fore and aft during ram and extract.



Safing/Firing Cam (Exploded View)



25mm Gun Subassembly

The main bearing is placed over the forward rotor, shouldered behind the main drive gear.

The rotor, less rear tracks and gun bolts, is slipped into the front end of the gun housing until the main bearing mates with its seat on the housing. A rear bearing and gear retainer are assembled to the rear of the rotor with the bearing seating in the rear of the housing. By tightening the bolts securing the rear gear,• the rotor is slightly preloaded inside the housing.

The forward bearing transmits breech loads directly from the front rotor to the housing. The rear bearing transfers mostly radial loads to the housing.

Barrels. The five barrels are assembled to the rotor by inserting them into the rotor and giving them a half turn. This locks the barrels longitudinally to the rotor. The center barrel clamp keeps the barrels from disengaging the rotor.

The center clamp, which is also a gun mount, is assembled to the cluster and secured by the five spacers between the barrels with one bolt each.

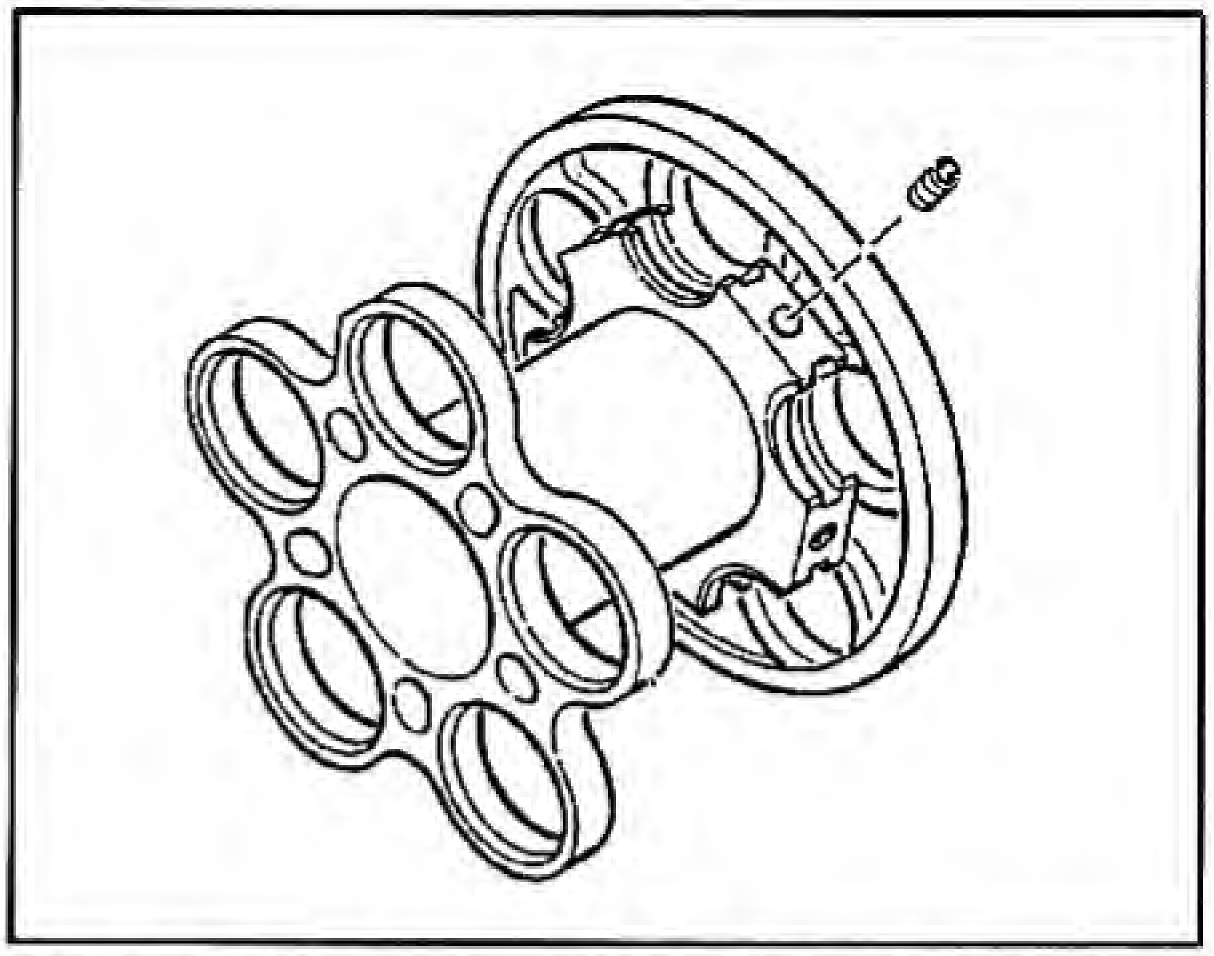
The muzzle clamp is placed over the ends of the barrels and also secured by spacers that are bolted to the clamp. On the very front of the muzzle clamp are provisions for placing a bushing and seal. They are used when the gun is installed in the aircraft to keep muzzle gun gas from coming back into the gun component, avoiding gun bay gas combustion and carbon deposits on the gun parts.

Gun Housing. The housing is a single piece steel casting. On its inside is machined the main cam for driving the gun bolts. On its outside are numerous machined pads for mounting gun components to the housing.

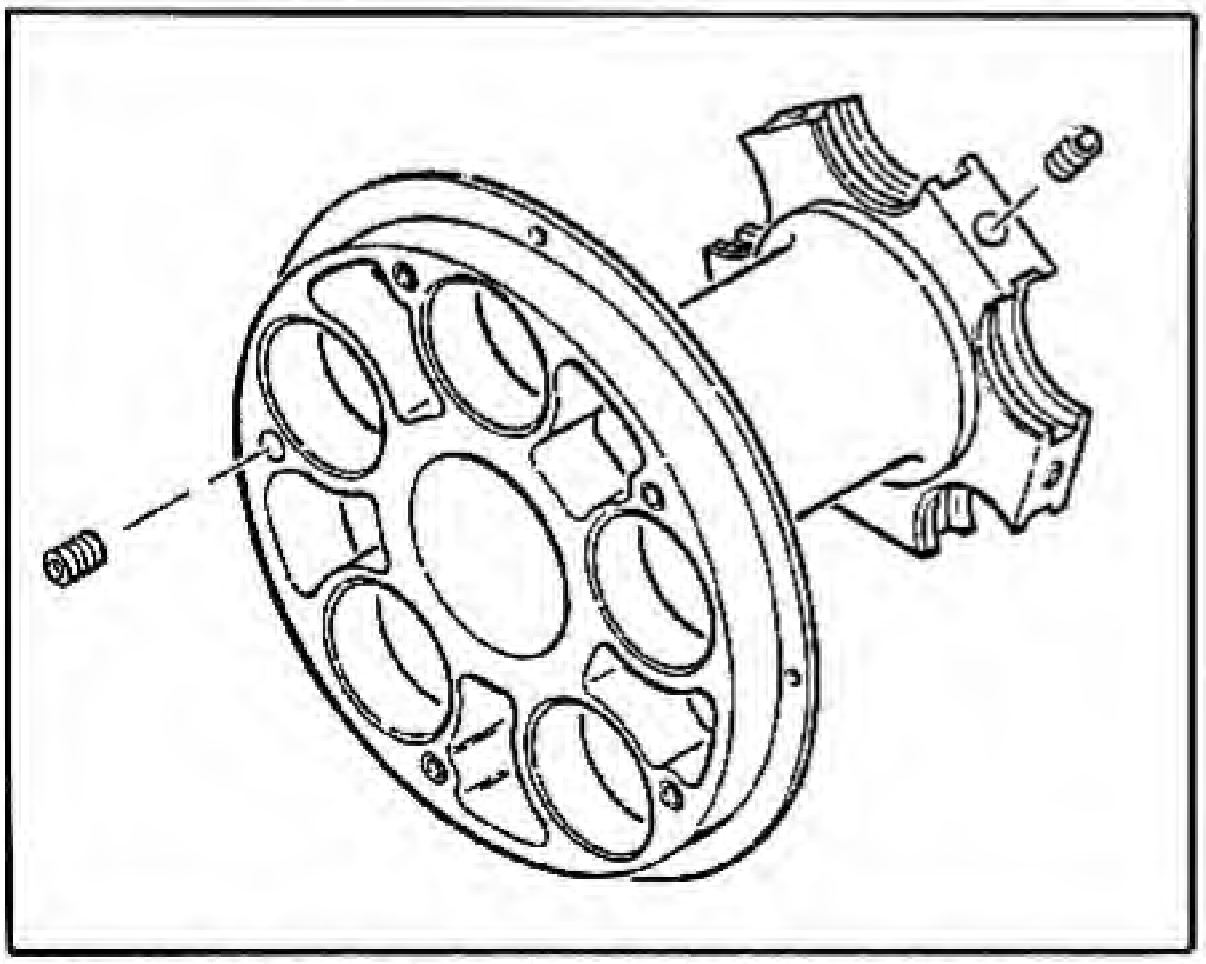
The lock-unlock cam and the safety and cocking cam are mounted forward and on top of the housing. Underneath, from 7 to 5 o'clock, is bolted the guide bar used to guide new ammo into the gun from the transfer unit and to extract spent cases out of the gun back into the transfer unit.

The recoil adapters connect to the housing on its forward end and straddle the 50° firing sector. This location is immediately next to the main bearing so that the shortest force path is attained in transferring breech loads from the bearing to the recoil adapters and hence to the aircraft.

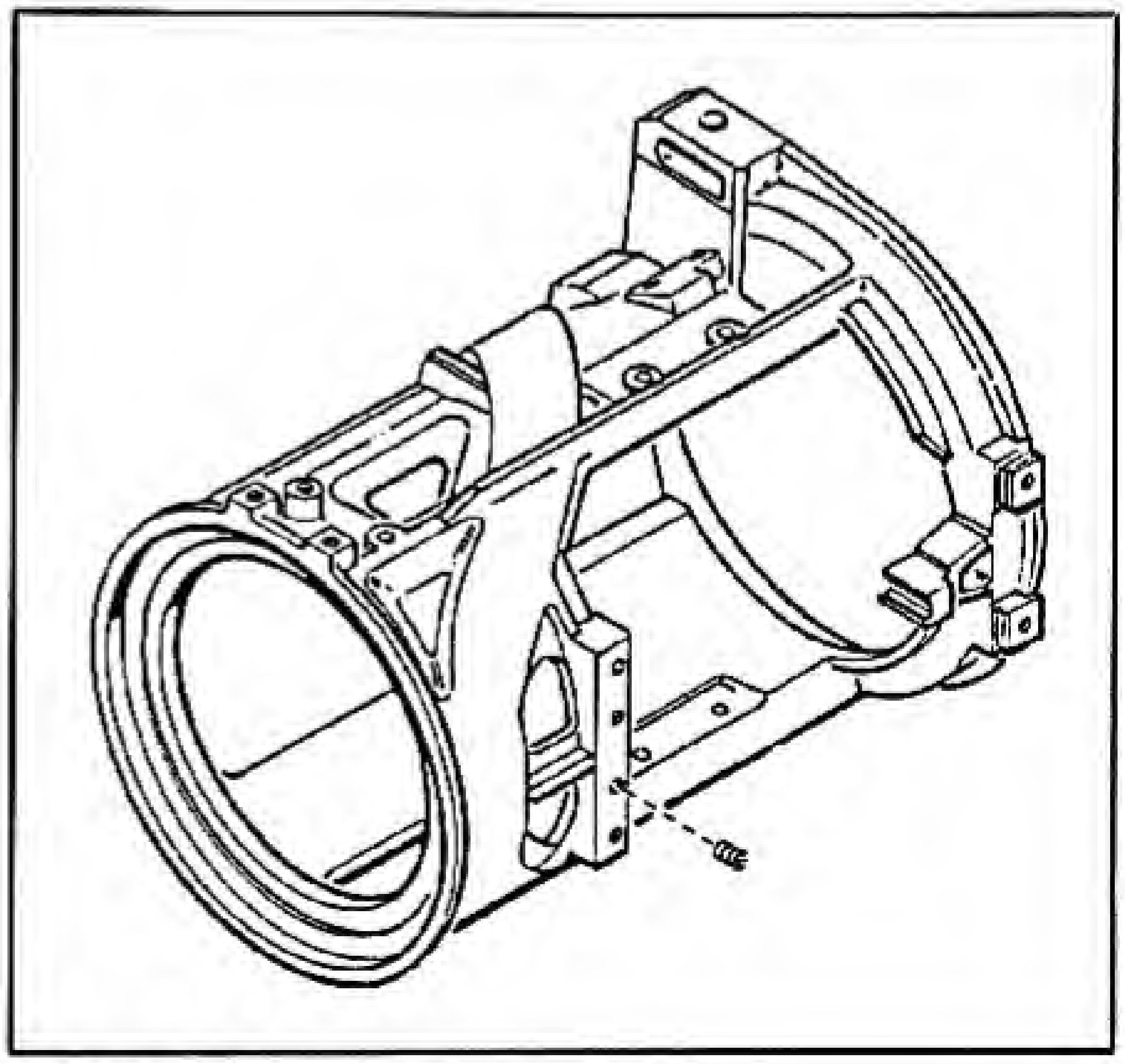
The gun drive adapter is bolted to the rear of the



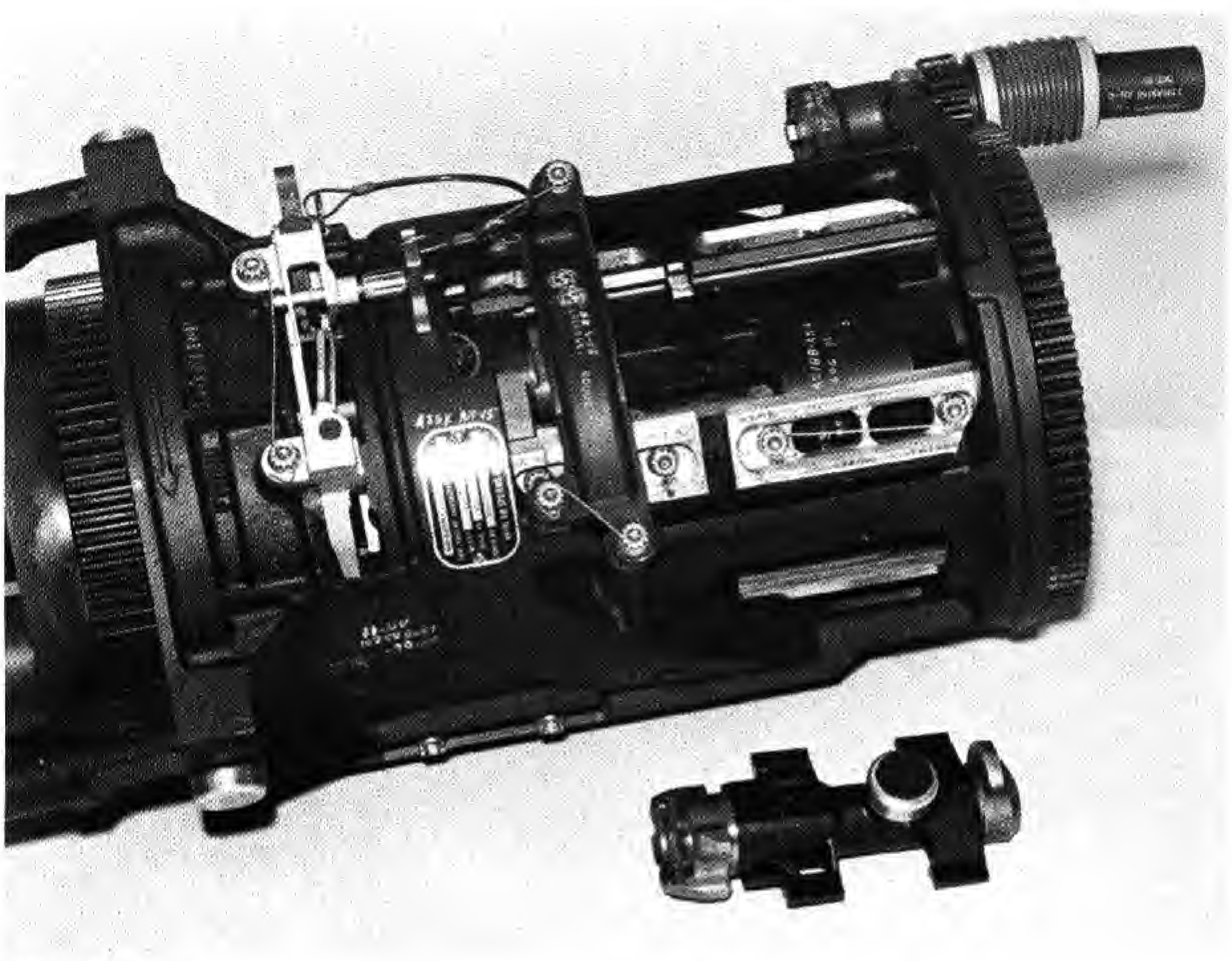
GAU-12/U 25mm Automatic Gun (Exploded View)



GAU-12/U 25mm Automatic Gun (Exploded View)



25mm Gun Housing



GAU-12/U Housing

housing supporting the drive pinion mesh with the rear rotor gear.

The transfer unit is bolted to the housing directly over the guide bar. New ammo is conveyed to the transfer unit where it is taken from the conveyor, passed to the load sprocket which, with the help of the guide bar, seats the round into the gun bolt face and extractor lip. After firing, the gun bolt hands-off the fired case to the unload sprocket, into the transfer unit and back into the endless conveyor.

The forward rotor gear drives the load and unload sprockets of transfer unit in-time with the gun.

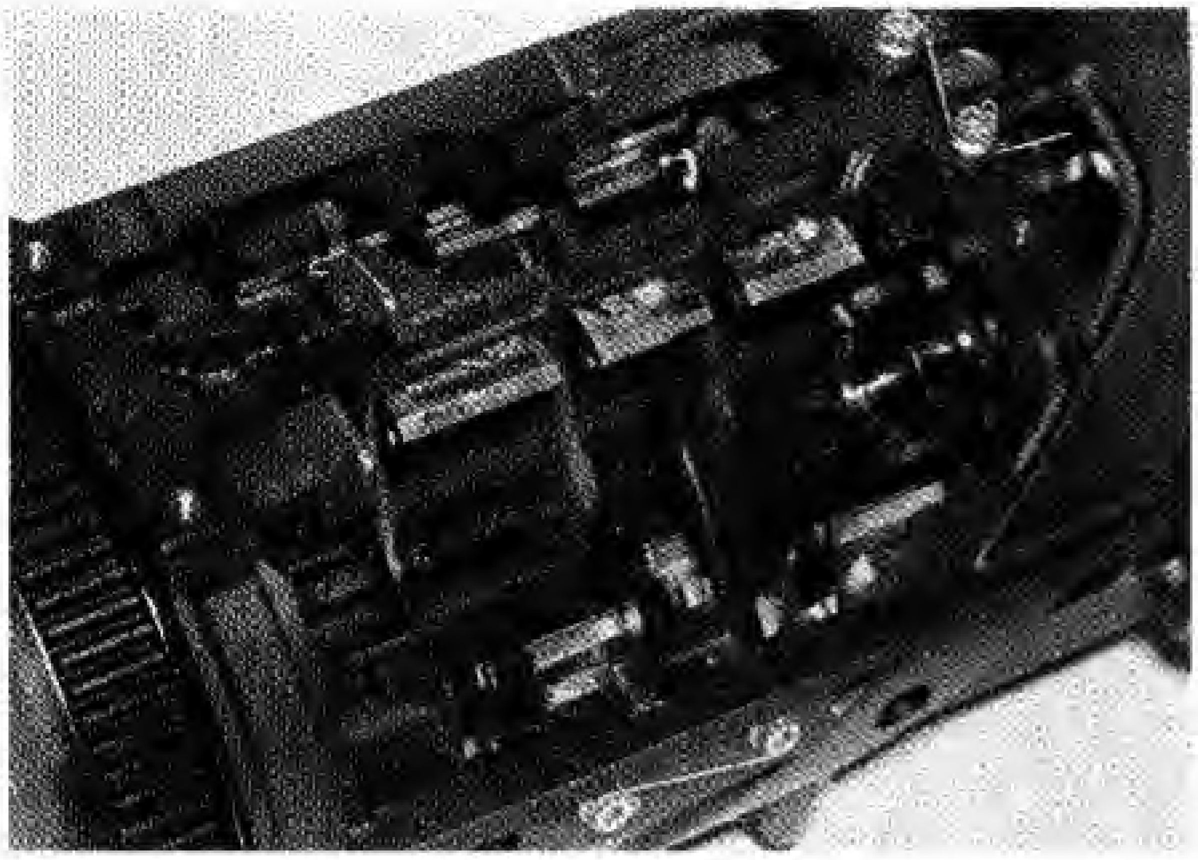
The installing of the gun bolts is accomplished through a cast opening at the top of the gun housing after removal of the lock-unlock cam and after the rotor-housing assembly is complete.

Linear Linkless Feed System For Equalizer

The Equalizer's Linear Linkless Feed System was the first of its kind to go into production at General Electric in 1981.

The Harrier AV-8B feed system, like the Equalizer Gun, is contained in a form fitting, pod-like structure bolted to the starboard underside of the aircraft's fuselage (the gun being on the port side). For effective usage, this pod design had to be long, slim and shallow. The requirement completely eliminated use of the rotary linkless feed used by Vulcan, Minigun and Avenger systems that have quite large cylindrical drums.

The design solution proved to be a linear linkless feed where the shape of the container was more



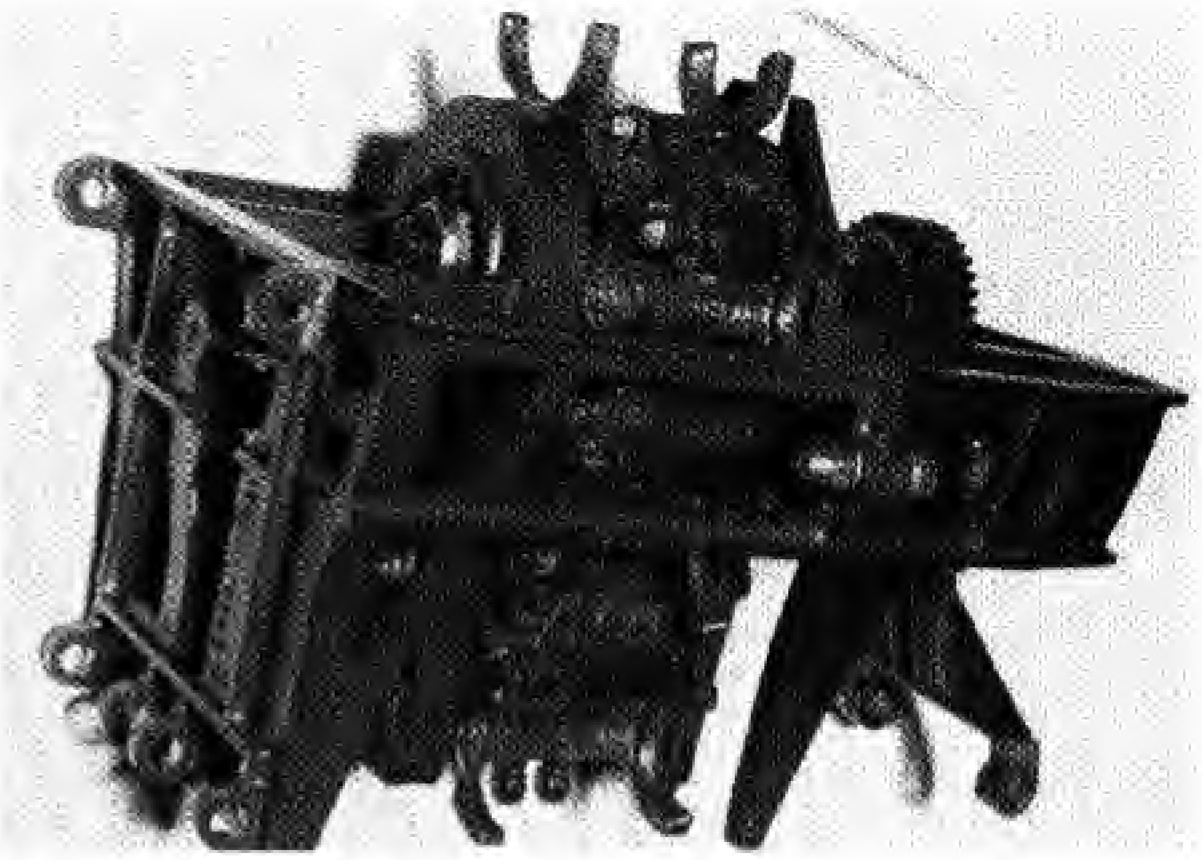
Linear Linkless Feed System Assembled

Characteristics

Type	5 Barrel Gatling
Gun Length	84 in.
Gun Weight	280 lbs.
Firing Rate	Up to 4200 rpm
Clearing Method	Reverse Rotation
Required Power	15 HP at 3600 rpm
Number of Barrels	Five
Barrel Life	3000 rounds minimum
Dispersion	7 mils (80% circle)
Recoil Forces:	
Peak (steady state)	7500 lbs.
Average (steady state)	7000 lbs.
Recoil Travel	1.00 inch (max.)
Counter Recoil Travel	0.40 inch (max.) excluding thermal growth of barrel cluster
Muzzle Velocity	3560 fps
Ammunition	25mm (HEI-T, TP-T, API, APDS-T, dummy)

rectangular than circular and for better fitting on the Harrier.

The Linear Linkless Feed System is a continuous loop of ammuniion conveyors that look like and are called "Ladders." The continuous loop of ladders is composed of a chain-like belt that is located on both ends of the ammunition, with a rod-like connector that attaches to each belt, the rod being alongside each round of the ammo. This produces a conveyor that provides a pocket for each round of ammo. The conveyor can make bends only and not twist or fan as in link-belt conveyors.

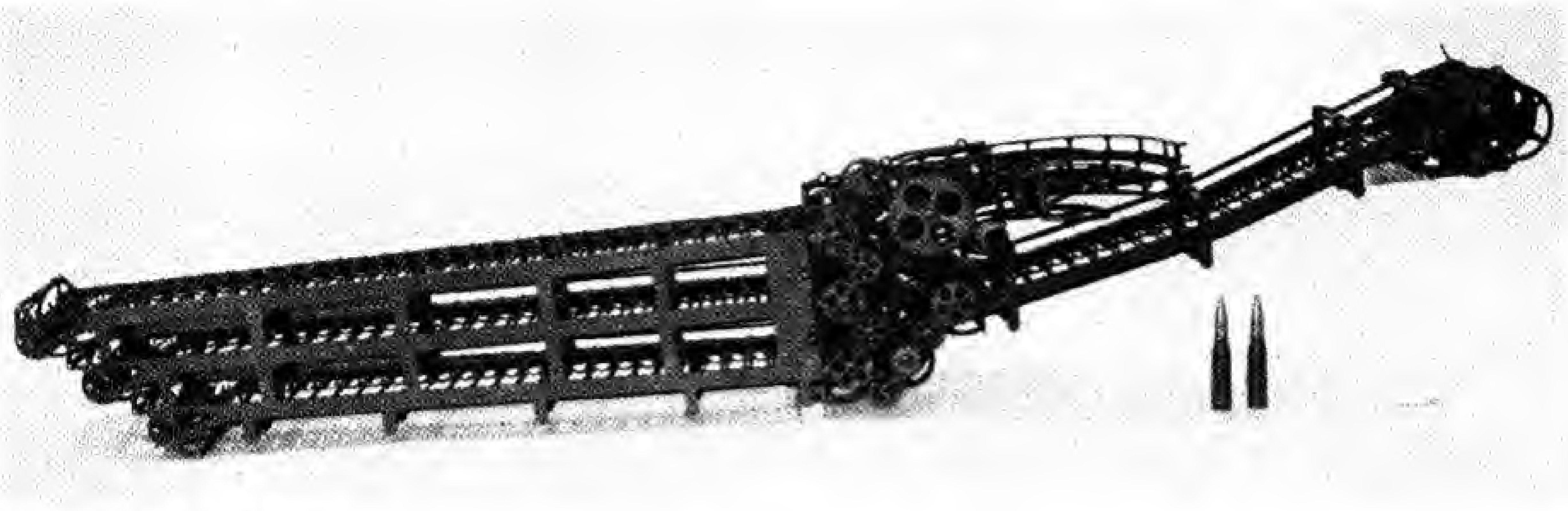


Linear Linkless Feed System

GAU-12/U Feeder

The linear ladders move with the ammunition through fixed channels that fold back on each other, forming a container of any convenient length and depth. Their width is a little more than the width of the ladder plus structure.

Rollers or wheels can be used where the ladders fold and make bends. These wheels can be sprockets



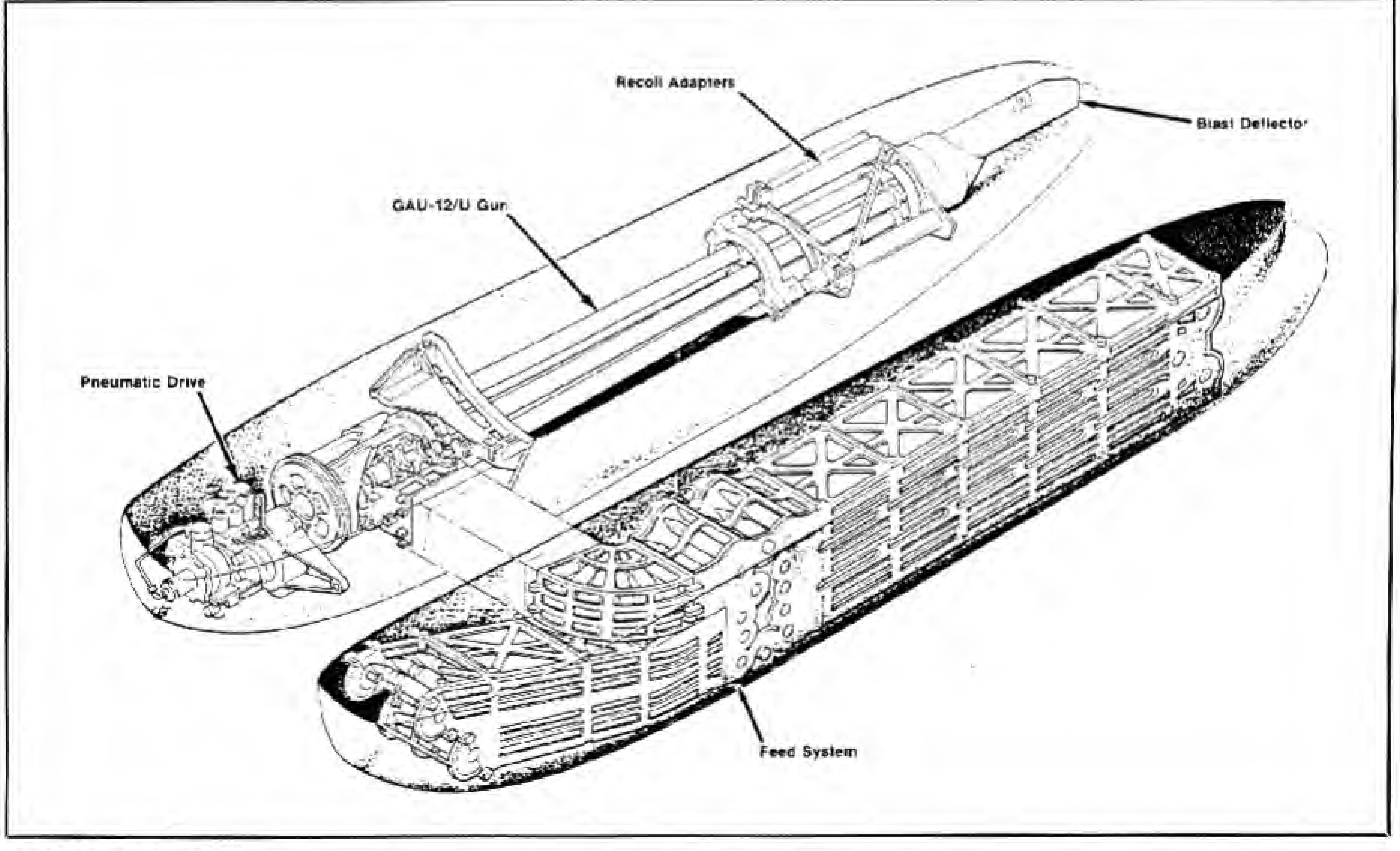
Linear Linkless Feed System

and can be driven to relieve load and stress on the continuous loop of belts or chains.

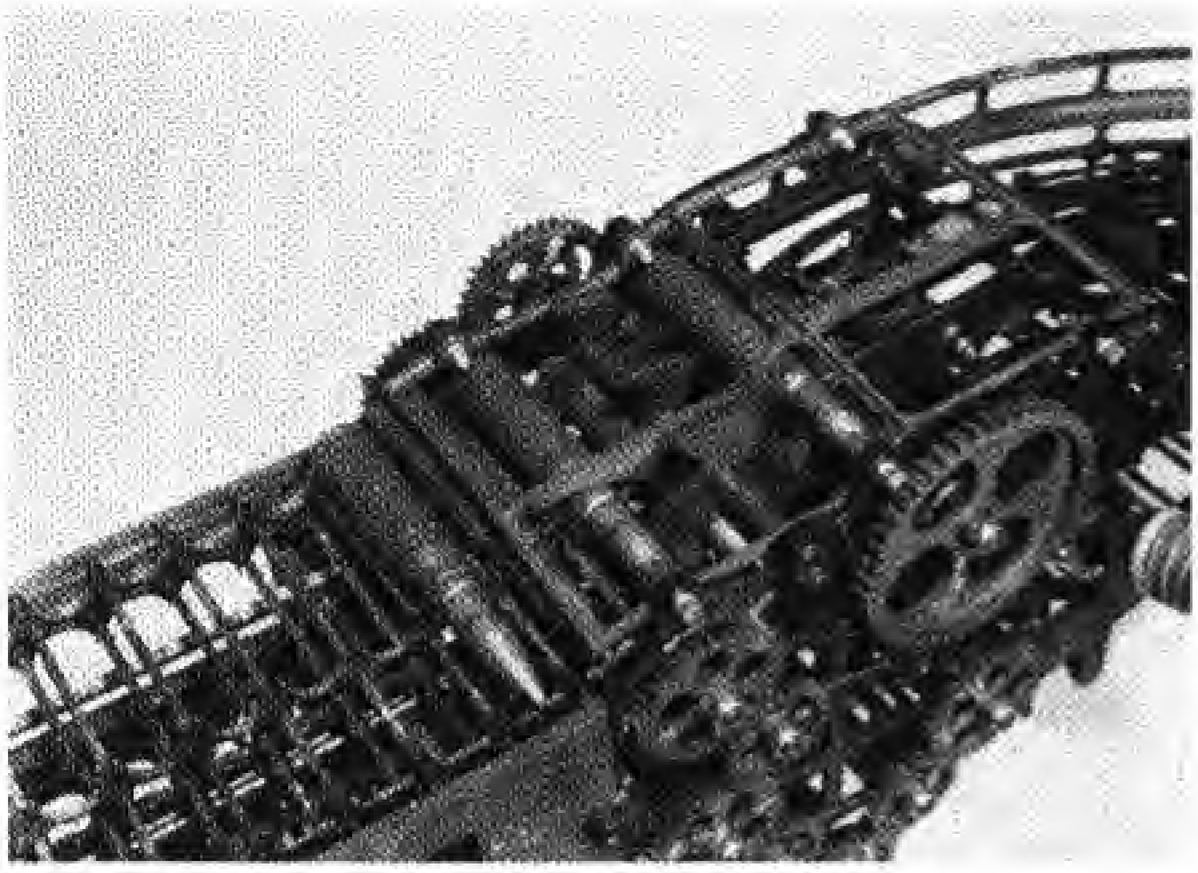
At any convenient place, ammo can be removed from the ladders (or replaced) by state-of-the-art scoops, guides and sprockets. This ammo can be conveyed to the gun and empty cases can be returned via the same conveyor loop to the linkless ladder storage compartment.

When the gun is firing, all ammo, all ladders and all conveyors move linearly at gun speed.

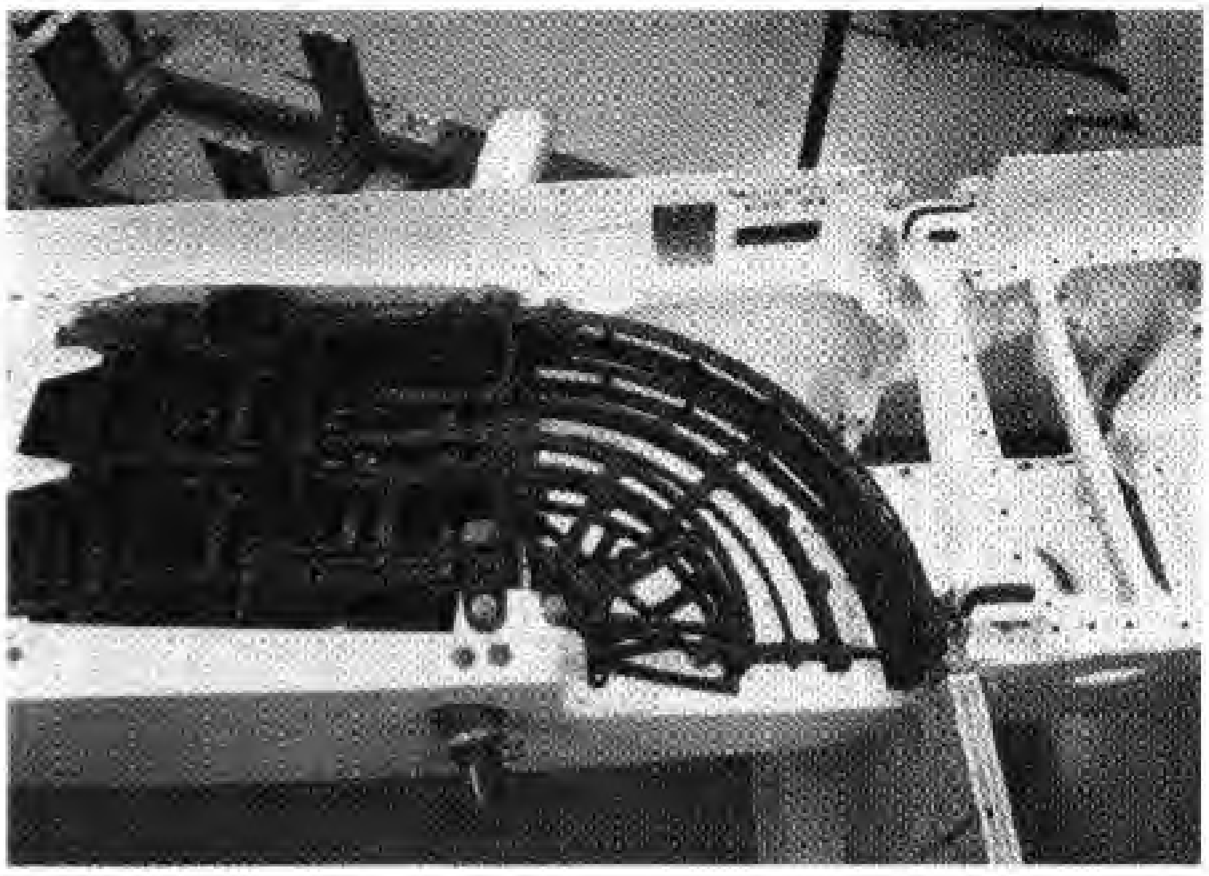
This is the Harrier AV-8 Equalizer Linear Linkless Feed System. The system contains 300 rounds of ammunition. It is loaded and downloaded by conventional means by attacking a loading unit and cranking in new ammo while scooping the cases out. This feed system and the gun run backward for reverse gun clearing at the end of each burst.

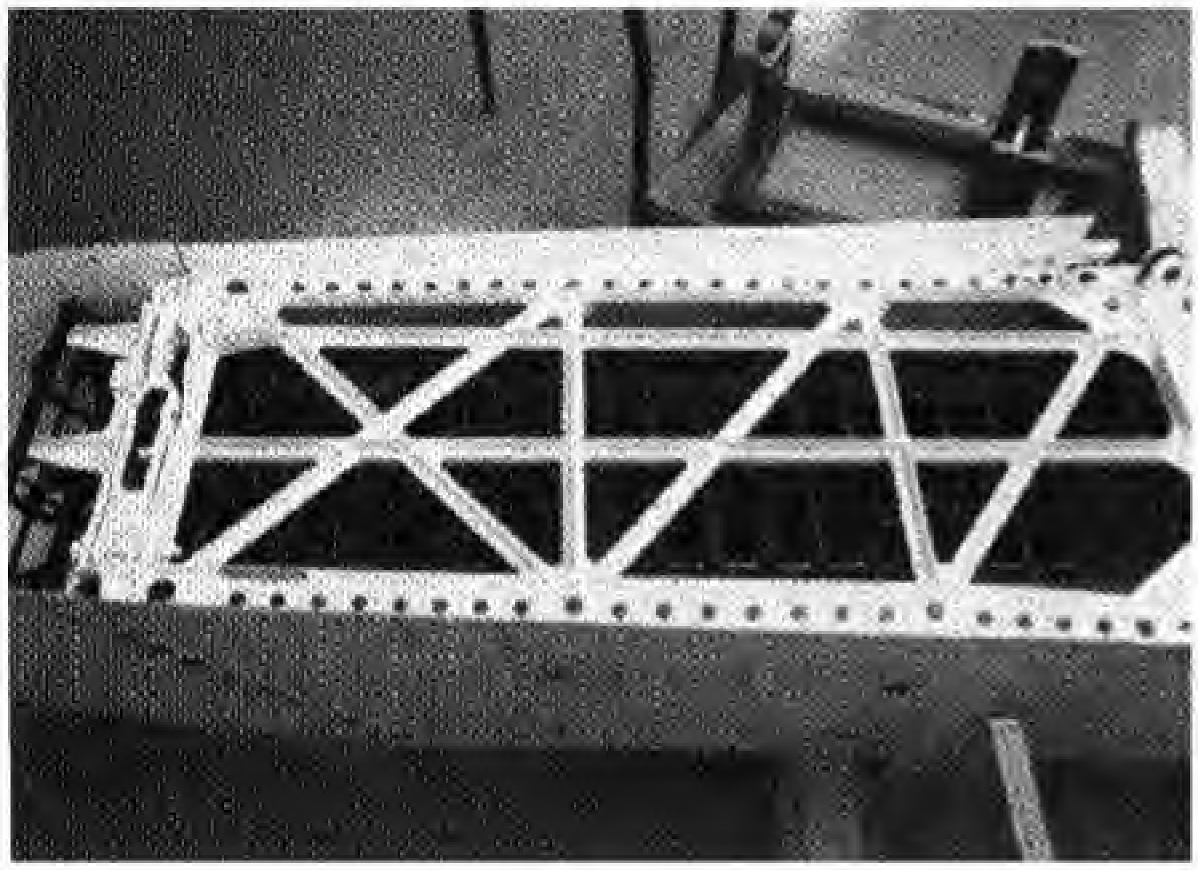


AV-8 Harrier System



Linear Linkless Feed System of AV-8 Harrier





Conveyor for Linear Linkless Feed System

Pneumatic Drive For Equalizer

On the Harrier AV-8B, the Equalizer GAU-12/U, 25mm Gun and Linear Linkless Feed System is driven to full firing rate of 3600 shots per minute by using a pneumatic gun drive.

The drive is located behind the gun in the Port pod. It is driven by engine bleed air from the Harrier's engine, driving the rotary motor at 9000 revolutions per minute developing over 35 horsepower.

Shafts using universals, splines and gear boxes connect the gun, the conveyor loop and the linear ladder loop, driving all units in time.

Harrier AV-8 Installation of Equalizer GAU-12/U Gun

The General Electric Company 25mm gun system for the Harrier is composed of two pod-like structures bolted to the underside of the aircraft. The port pod contains the Equalizer GAU-12/U gun and the pneumatic drive. The starboard pod holds the Linear Linkless Feed System and most of the 300 rounds of ammunition carried.

Between the two pods is a crossover fairing that contains a conveyor loop bringing new ammo from storage to gun, and empty cases back to storage. The power shaft from gun to feed system also crosses through this fairing.

In the gun pod, breech recoil forces are transmitted from the recoil adapters directly to the aircraft's

System Characteristics

Gun	25mm GAU-12/U
Weight:	
Gun	275 lbs.
System (loaded)	1230 lbs.
System (empty)	900 lbs.
Firing Rate	3600 spm
Muzzle Velocity	1065 M (3500 ft/sec, HEI, TP)
Muzzle Velocity	1036 M (3400 ft/sec, API)
Feed System	Linear Linkless, Closed Loop
Drive System	Pneumatic
External Power Requirements	28 VDC 15 Amps max.
Barrel Life	15,000 Rounds Per Set
Reliability	20,000 MRBF
System Life	250,000 rounds
Dispersion	6 mils (80%, 6 mil. circle)
Ammunition	Standard 25mm (TP, HEI, API)
Ammunition Capacity	300 rounds

AV-8 Harrier

forward pod mounting point through a very light weight structure.

During firing, the projectiles pass through a small hole in the nose of the gun's streamlined pod. Inside this nose is a chamber that strips muzzle gun gases from the projectile, collects the following gas and directs it both downward and out of the chamber. There is a bushing and a seal between the gun's muzzle clamp and this chamber to support the muzzle dynamically and to keep gun gases out of the gun compartment avoiding flashing and carbon buildup on the hot gun parts.

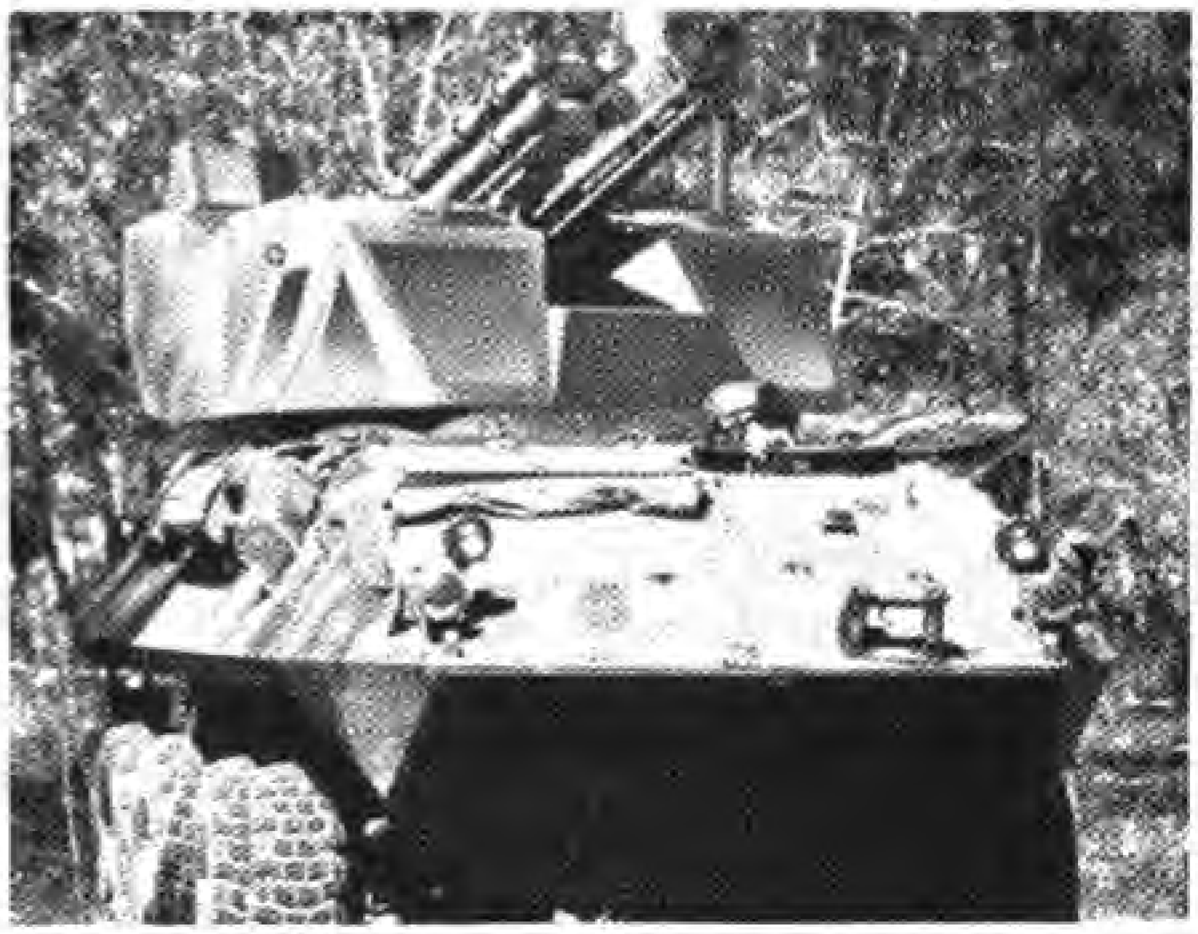
Application of Equalizer on the Light Armored Vehicle Air Defense

The General Electric Light Armored Vehicle Air Defense System (LAV/AD) incorporates the Blazer-25 hybrid turret that contains the Equalizer GAU-12/U 25mm Gun and Linear Linkless Feed systems. This turret is to provide the U.S. Marines with a tactically flexible weapon system to defeat assault helicopters, strike aircraft and ground armor.

The two-man turret provides a 360° field-of-fire. The Linear Linkless Feed container is located on the azimuth function inside the crew-served vehicle and contains 500 rounds of ammunition with on-board reload capability.

The Equalizer fires at 2200 shots per minute and is electrically driven. Reverse gun clearing is used after each burst. The spent cases are ejected overboard from the gun and not returned to the linear storage system.

AV-8B Armament System

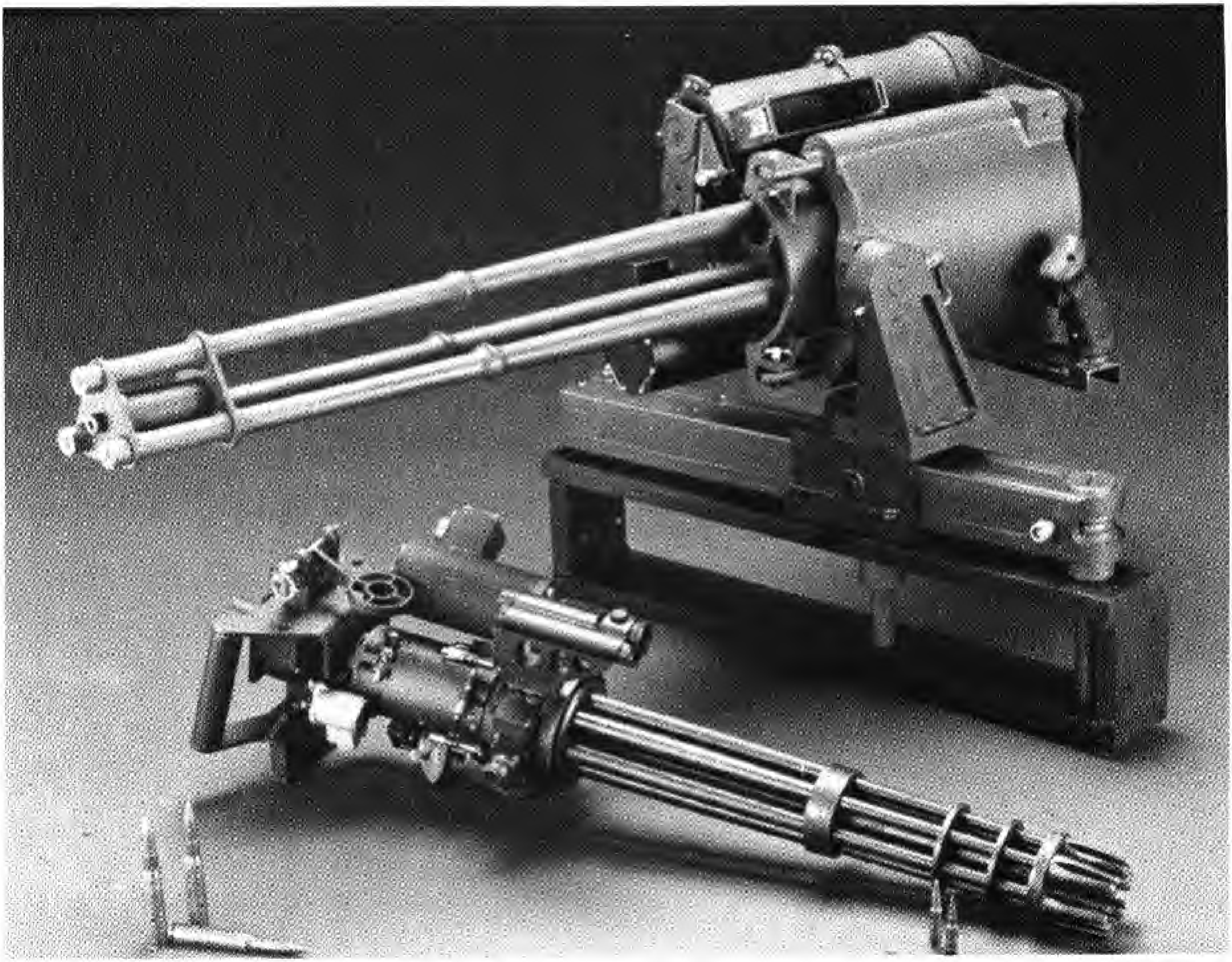


LAV/AD Light Armored Vehicle Air Defense

Chapter 15

GECAL .50 MACHINE GUN

GENERAL ELECTRIC



Three and Six Barrel Configuration of GECAL .50

History

U.S. utility helicopters are armed with the 7.62mm single-barrel M60 and multi-barrel GAU-2 guns. Their effectiveness in the ground fire suppression role is limited by a 700-800 meter maximum effective range and an extremely limited armor penetration capability, only 1/8 inch at 800 meters.

The calibre .50 M2 machine gun is also utilized, and has a superior effective range to the 7.62mm weapon; however, use of the M2 is limited by the following:

- Single firing rate, too low for an air-to-air engagement.
- Limited control of ammunition ballistics because of internal ballistics constraints imposed by recoil operation of the weapon.
- Low reliability, considerably less than 10,000 MRBF (Mean Rounds Between Failures).

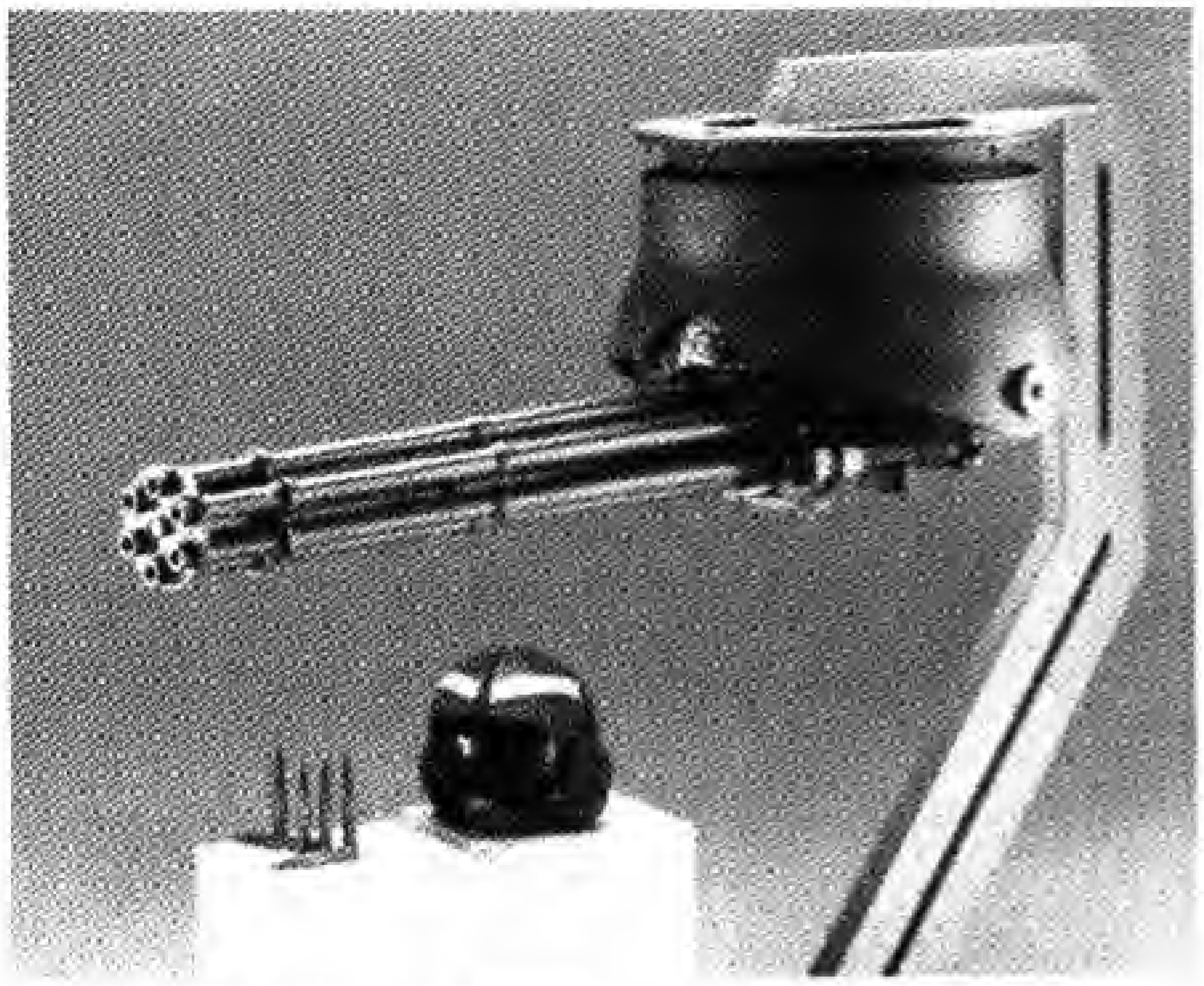
Characteristics

Type	Externally powered, lightweight Gatling, calibre .50 (12.7mm NATO)
Length	46.5 in. (1181mm)
Weight: 3-BBL	66 lbs. (30 kg)
6-BBL	96 lbs. (43.6 kg)
Power to Drive	4.8 HP @ 4000 spm
Rounds to First Scheduled Maintenance	15,000 rounds
Reliability	50,000 MRFB
Ammunition	TP, M-8 API, APHC (1), NM 140, M-17 tracer
Dispersion (80% of rounds fired)	6 mil
Rate of Fire	4000 (max) SPM (Linked ammo) 8000 (max) SPM (Linkless feed)
Time to Rate	0.4 seconds

Recoil Forces:	3-BBL @ 1500 spm	3-BBL @ 4000 spm	6-BBL @ 6000 spm	6-BBL @ 8000 spm
Peak Recoil Force	900 lbs. (4.0 KN)	1600 lbs. (7.1 KN)	2200 lbs. (9.8 KN)	2900 lbs. (12.9 KN)
Peak Recurrent	800 lbs. (3.6 KN)	1600 lbs. (7.1 KN)	2000 lbs. (8.9 KN)	2150 lbs. (9.6 KN)
Average Recoil Force	450 lbs. (2.0 KN)	900 lbs. (4.0 KN)	1350 lbs. (6.0 KN)	1700 lbs. (7.6 KN)

Drive Type	Electric, Hydraulic or Pneumatic, Gun Gas
Feed System	Linked or Linkless
Clearing by	De-Clutching Feeder (Linked) Gun Reversal (Linkless)

The GECAL .50 after 3000 rounds fired in 200 round burst at 6000 spm



Calibre .50 Composite Turret

Black Hawk Weapons System

A need for an improved variable rate-of-fire weapon for the utility helicopter role was stressed at the USMC Armament Conference, June 12, 1980. Recommendations from the conference were to investigate a new weapon capable of being fired manually by a gunner from a pintle mount or by the pilot with the weapon in a fixed forward position for air-to-air combat and ground threat suppression.

The development of a new weapon solely to meet the armament requirements of the utility helicopter is hampered by the significant cost of introducing a new weapon into the inventory. If present day threats to utility helicopters are to be suppressed, a replacement weapon must be found which is effective and versatile enough to justify the development costs.

Description

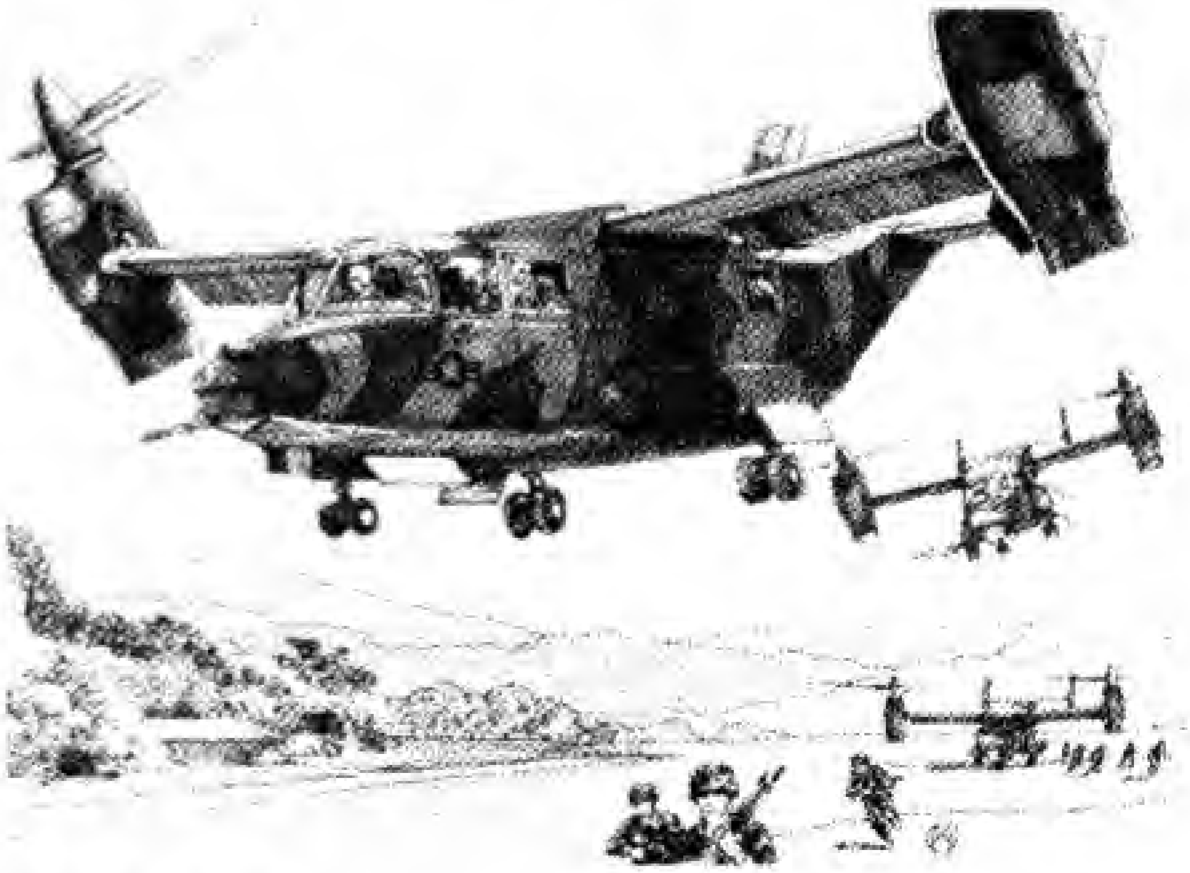
Previous trade-off studies established a six-barrel calibre .50 weapon with a six-barrel alternative configuration of the optimum multi-purpose, multi-role design. This baseline design provides a maximum firing rate of 8000 shots per minute to meet fixed-wing air-to-air requirements and a lightweight three-barrel configuration with a 4000 shots per minute capability for helicopter utilization. It was also established that the gun design should accommodate the projected need for a self-powered (gas driven) option.

Aircraft evaluated for this type of armament include all model helicopters and tilt-rotor utility aircraft.

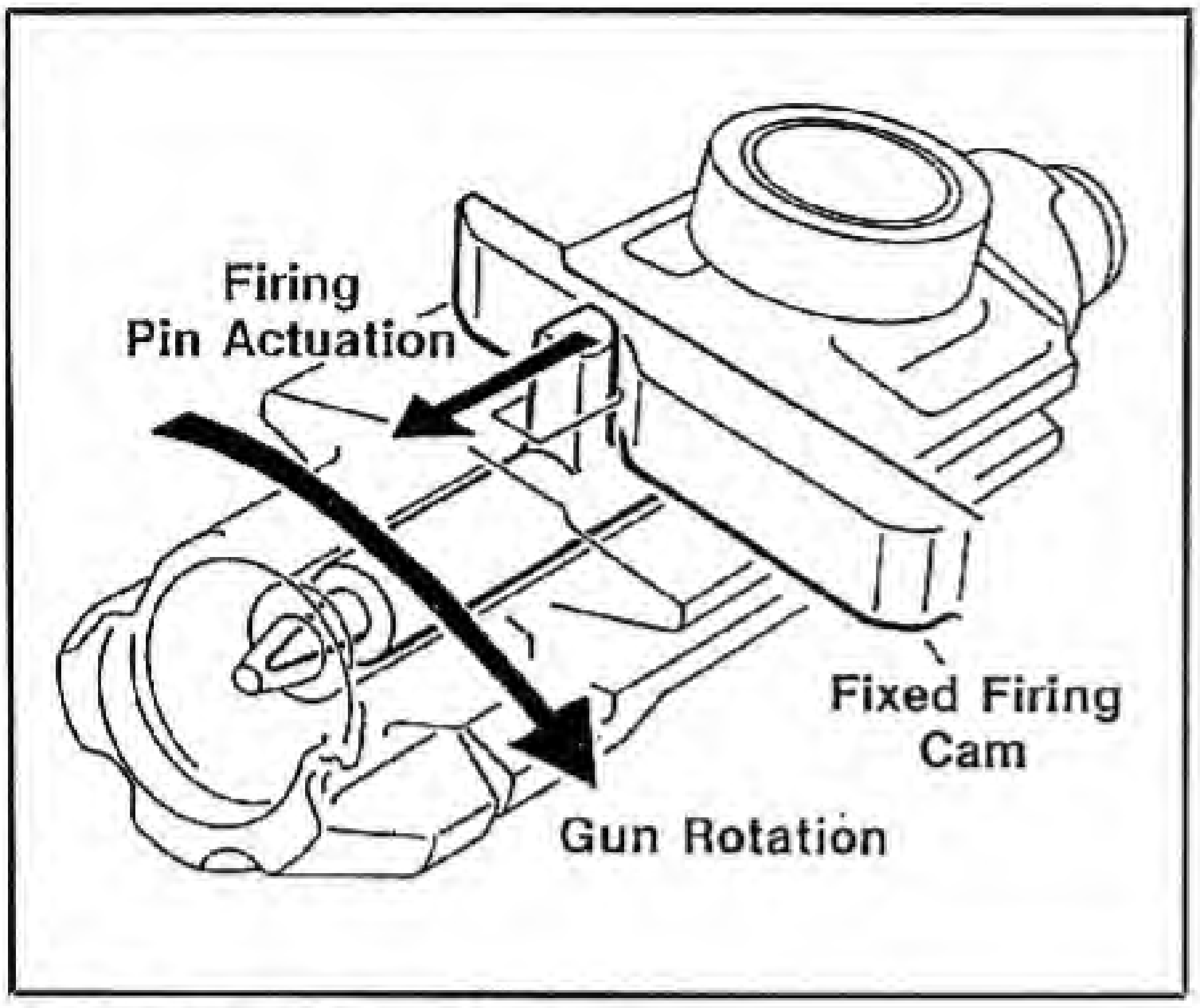
Design criteria that were emphasized to meet the multi-role mission requirement with the lowest life cycle cost included the following gun features:

- Six barrels
- 8000 shots-per-minute maximum firing rate
- Fully compatible with both linked and linkless ammunition handling
- Convertible from a six-barrel to a three-barrel configuration
- Simplified maintenance
- Internal gas drive option
- Maximum utilization of proven technology

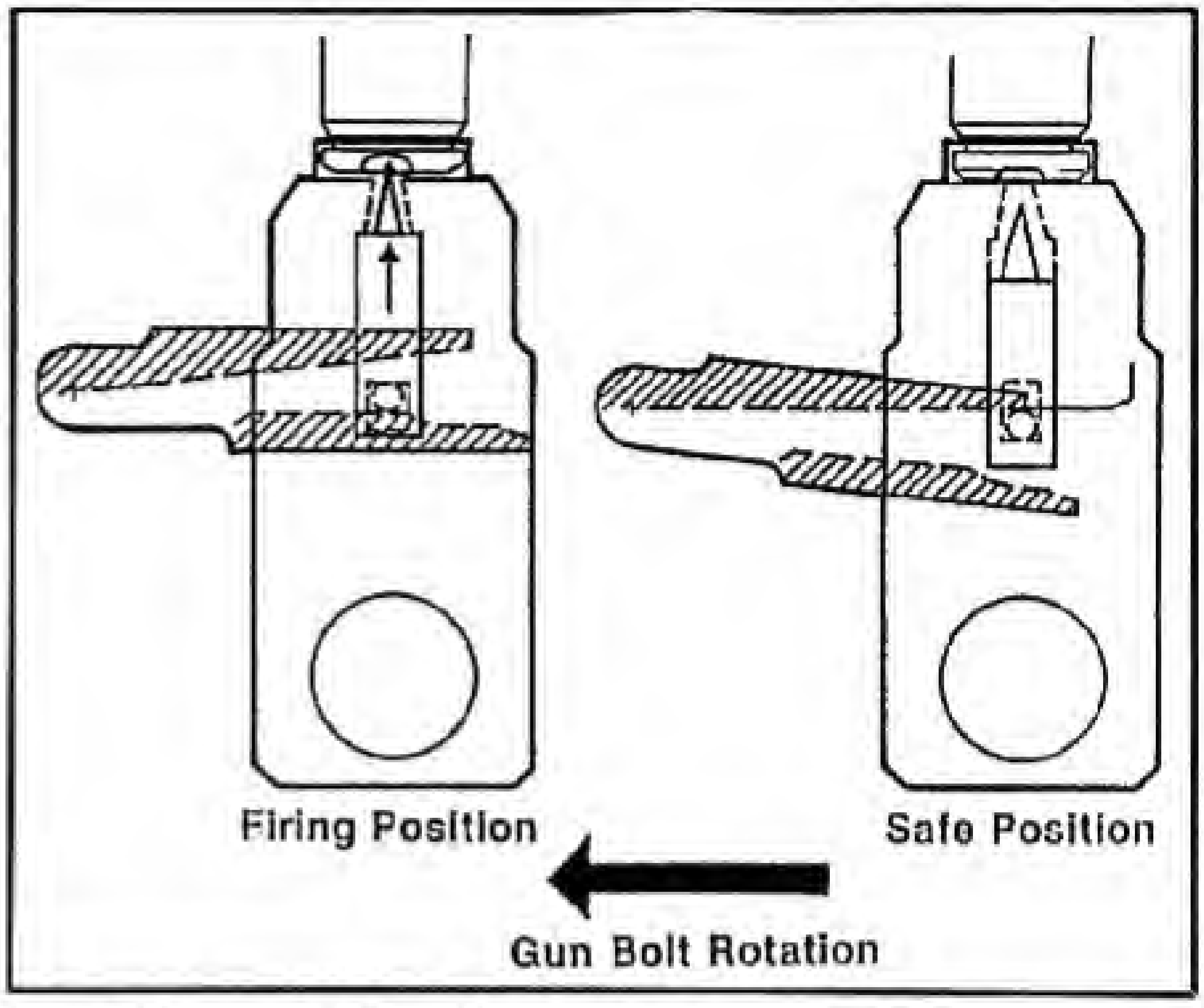
The calibre .50 gun built in 1983 is similar in design to the 30mm GAU-8 and GAU-13, and the 25mm GAU-12 weapons. The gun has six barrels, is 46.5



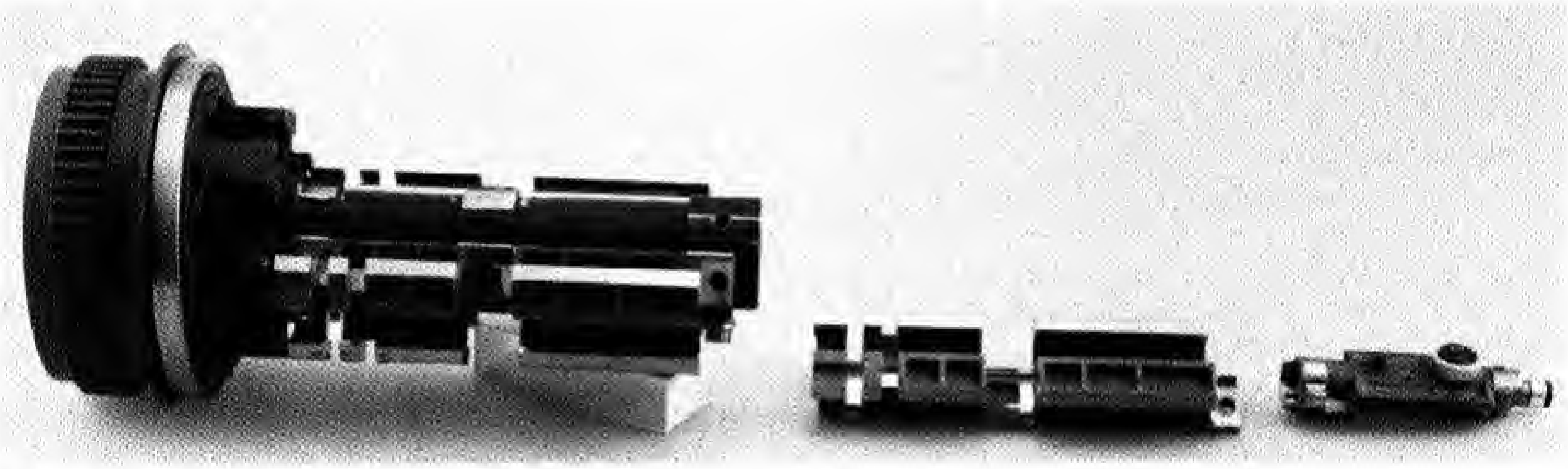
V-22 Pintle System


Firing
Pin Actuation
Fixed Firing
Cam
Gun Rotation

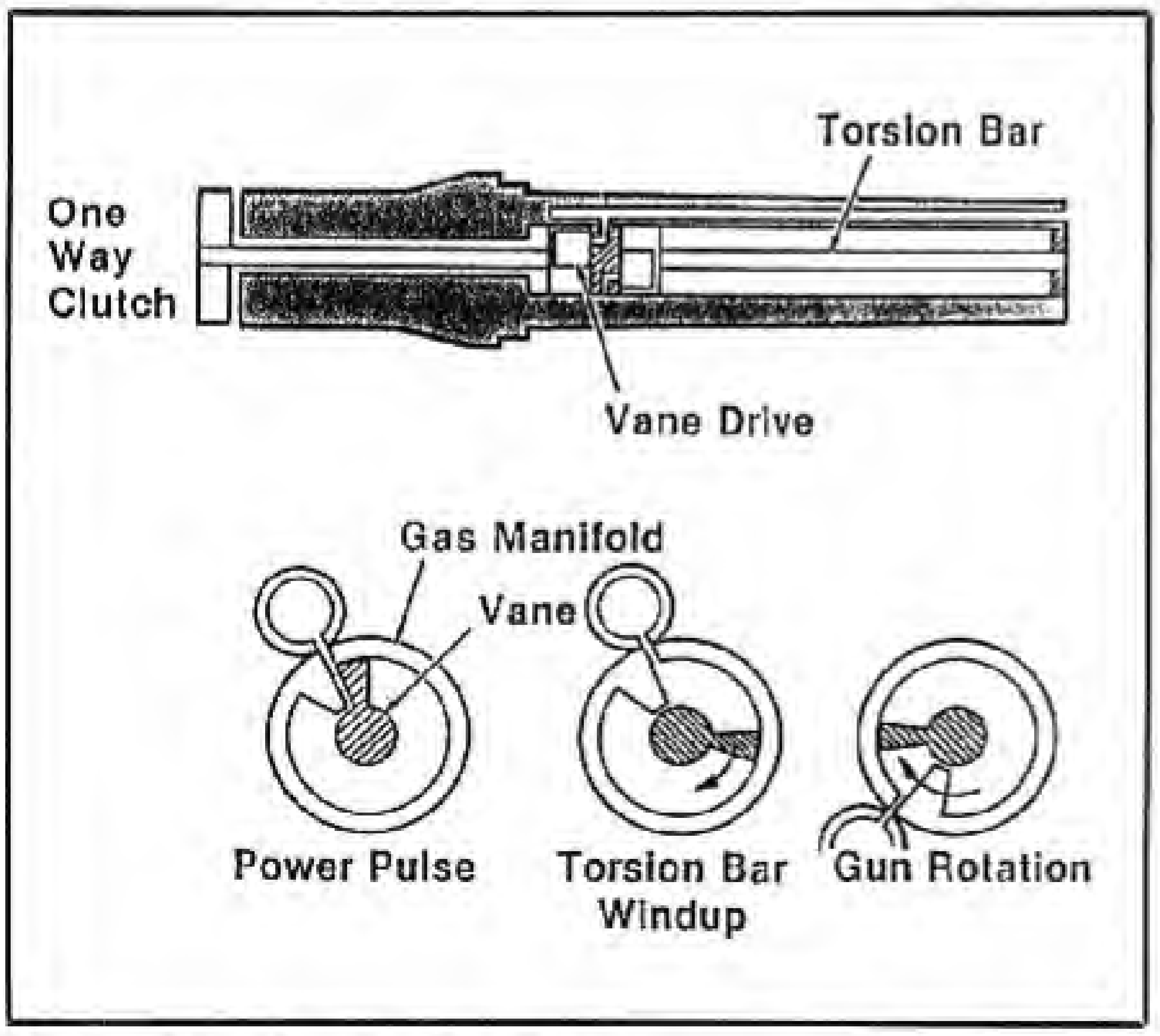
Inertial Firing/Safing Mechanism


Firing Position
Safe Position
Gun Bolt Rotation

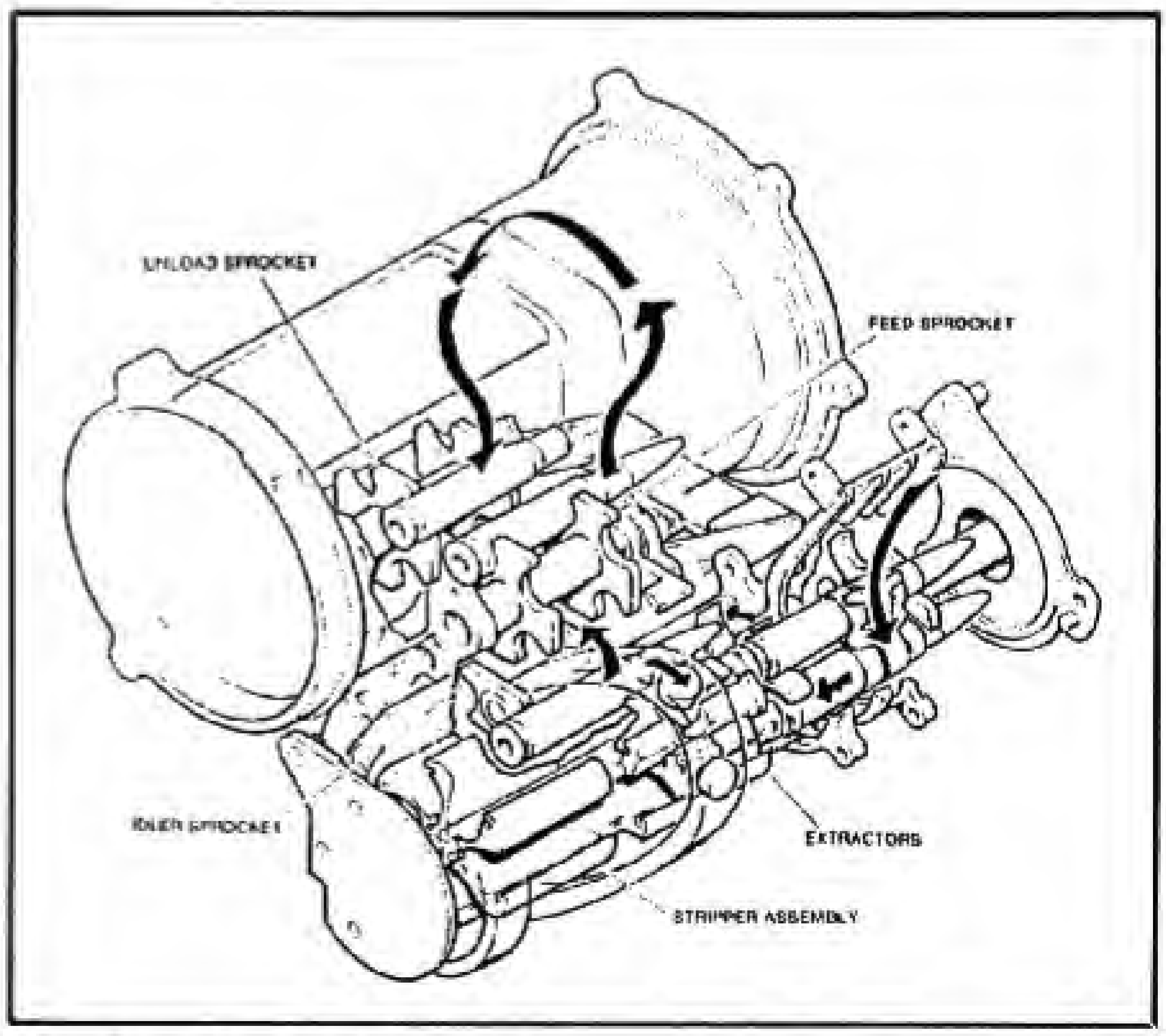
Inertial Firing/Safing Mechanism



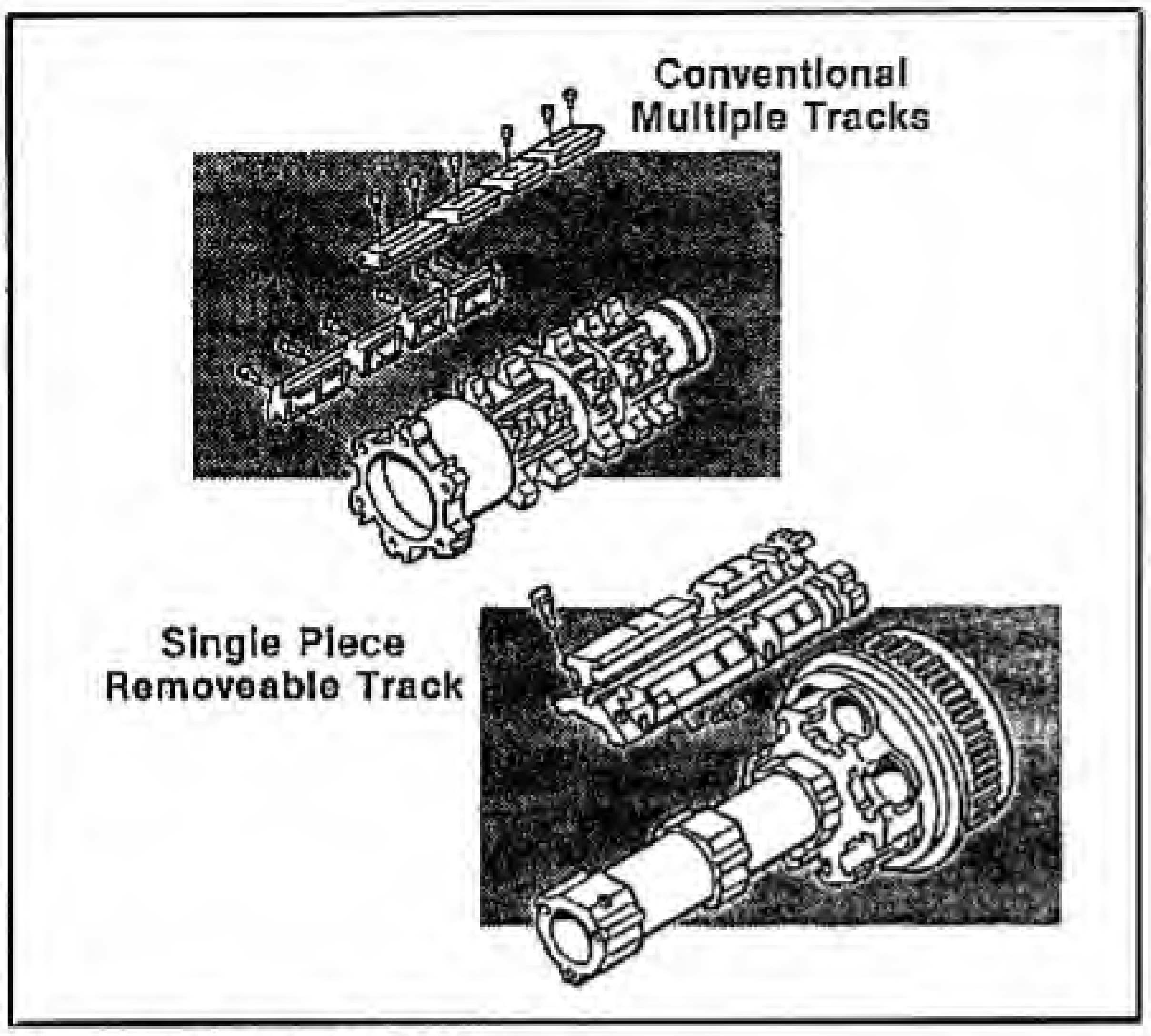
Drive and Locking System Assembly of Caliber .50


Torsion Bar
One
Way
Clutch
Vane Drive
Gas Manifold
Vane
Power Pulse
Torsion Bar
Windup
Gun Rotation

Optional Self Starting Gas Drive


UNLOAD SPROCKET
FEED SPROCKET
IDLER SPROCKET
EXTRACTORS
STRIPPER ASSEMBLY

Delinking Feeder Mechanism



Simplified Track Design

inches long and weighs 96 pounds. Features of the gun include unique firing mechanism, adaptable mounting, easy conversion from six to three barrel configuration and simplified bolt assembly.

The gun fabricated in 1983 was subjected to 10,000 rounds of fire testing in 1984. The complete firing rate spectrum was investigated and data was collected for all the significant performance characteristics.

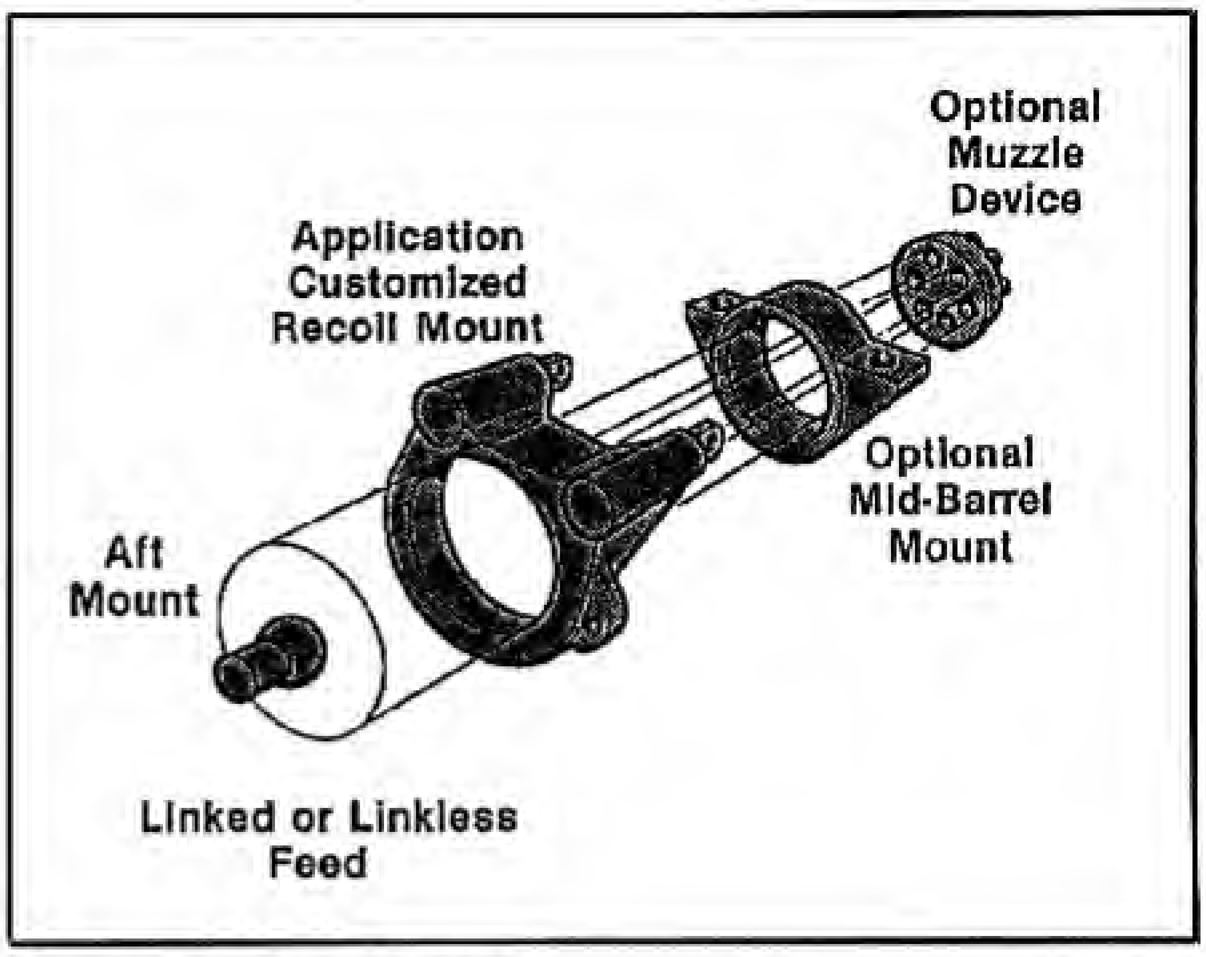
The gun was configured with a transfer unit and closed loop of linkless feed conveyor elements to provide a realiable high-rate feed mechanism. Two short lengths of flexible chuting were mounted between the fixed feed and return chuting and the transfer unit.

Delinking Feeder

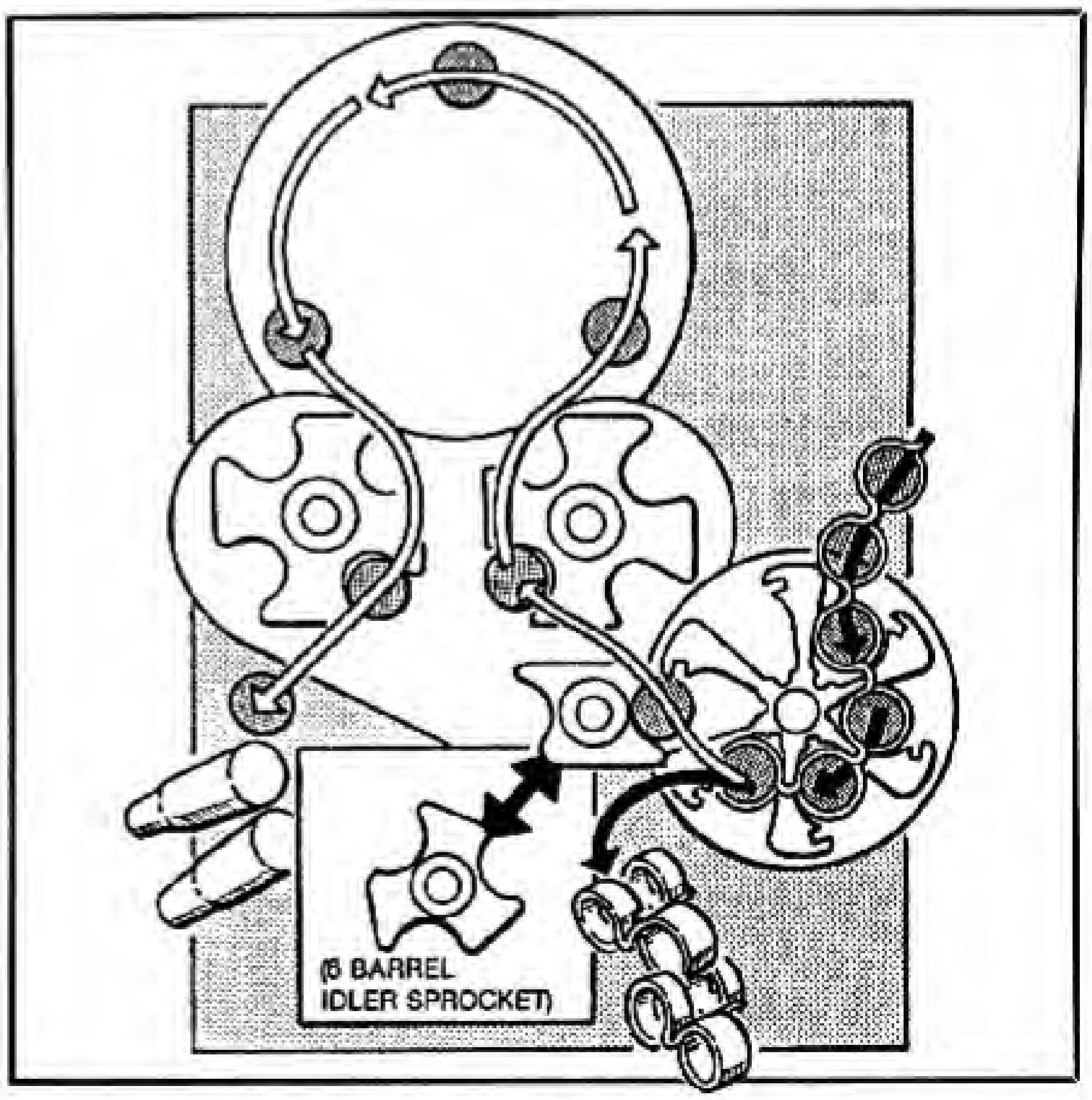
The application of the calibre .50 gun to helicopters, particularly for pintle mounts, established the need to belt-feed linked ammunition directly to the gun. The feeder built and tested in 1985 utilizes calibre .50 ammunition belted with the M9 link, as is used with the M2 Browning. An original design objective of accommodating both the M9 and M15A2 links was abandoned as being impractical. The M9 link is by far the more prevalent link.

The delinking feeder mechanism is designed as two major assemblies: the transfer unit bolts directly to the gun, and the stripper assembly is a quick-removal assembly.

The transfer unit consists of the guide bar, and forward and aft housings within which are mounted the feed, unload and idler sprockets. The feed and unload sprockets are geared directly to the gun and pass live rounds and spent cases to and from the gun bolts. The idler sprocket, which is gear driven by the stripper assembly, accelerates ammunition from the stripper pitch to the feed sprocket pitch. The quick-removal stripper assembly pulls the linked ammunition belt through the chuting, withdraws the rounds axially rearward from the links and passes the ammunition to the transfer unit.


Optional Muzzle Device
Application Customized Recoil Mount
Optional Mid-Barrel Mount
Aft Mount
Linked or Linkless Feed

System Interface Versatility



Ammunition Path of a Feeder Configured for a Three-Barrel Gun

The forward mount, which provides the recoil and drive motor interface with the gun, also incorporates the feeder clutch.

Cycle of Operation

When power is applied to the gun drive and feed clutch solenoid, the clutch picks up the stripper assembly which delinks the ammunition and passes it to the transfer unit which in turn feeds the gun. Spent cases are removed from the gun by the unloaded sprocket and discarded. The empty links are ejected by the stripper assembly. When power is removed, the clutch stops the stripper while the gun fires out the remaining rounds. The clutch design and gun clearing function are identical to that used on various 7.62mm and 20mm systems of similar design.

The two-tooth idler sprocket is driven by the stripper assembly through an elliptical gear set. The idler sprocket feeds alternate openings in the four-tooth feed sprocket which is geared directly to the gun. The alternate configuration is used to feed a six-barrel gun. The idler sprocket has three openings, is driven from the stripper by circular gearing rather than elliptical and feeds each position of the four-tooth feed sprocket. This design provides 90 percent commonality between feeders configured for three- and six-barrel guns. The stripper, housings and guides are identical. Only one sprocket and three gears are different.

Additional testing of the calibre .50 weapon during 1985 included firing from a test fixture mounted in a UH-1N to determine aircraft loads and firing from the Boeing Aerospace Air Defense System AVENGER to verify system response. Basic compatibility was demonstrated in both evaluations.

Follow-On Gun Development

A limited amount of follow-on gun development was conducted in 1985. Improvements to the firing mechanism have established 1,000 rounds per minute as the minimum low rate for the inertia firing pin energy approach. For lower rates of fire, firing pin springs would be required. It is not anticipated that rates below 1,000 spm would be required for this type of weapon. Additional producibility reviews provided production design changes that will reduce cost.

PART XIII

RECOIL (RECIPROCATING) OPERATED CANNONS AND MACHINE GUNS

Chapter 16

CALIBRE .50 MACHINE GUN DEVELOPMENT

SECTION I.

CALIBRE .50 M2 MACHINE GUN

BROWNING

History

The requirement for the calibre .50 machine gun was formulated in 1917 by General J.J. Pershing to meet the threat posed by the appearance of an armored German airplane. Since the French Hotchkiss 11mm antiballoon gun was already a success, attempts were made to utilize that cartridge in a modified calibre .30 Browning. The ammunition performance was not adequate, however.

In response to the requirements for a machine gun firing a projectile of at least one-half inch diameter at a velocity of 2700 feet per second, John M. Browning began working on the problem in mid-1917. The work was done mostly at Colt's Patent Fire Arms Company. In the space of about a year Browning had scaled up the basic design of his successful calibre .30 machine guns to accept a Winchester designed calibre .50 cartridge. The first testing was done on Armistice Day, November 12, 1918. By the middle of the next year, an improved cartridge had been developed by Winchester and was in production at Frankfort Arsenal. Browning had added a hydraulic buffer to his gun to compensate for the increased recoil of the more powerful cartridge.

The model 1921 Water Cooled Browning Machine Gun was the first calibre .50 in U.S. service.

In 1933, the M2 series of calibre .50 Brownings was standardized. Much of the credit for the modifications needed to permit mass production of these guns belongs to Dr. S. Y. Green. His work allowed the production of one receiver which could be used for any one of seven versions of the gun. Many other individuals also aided in the improvement of the gun.

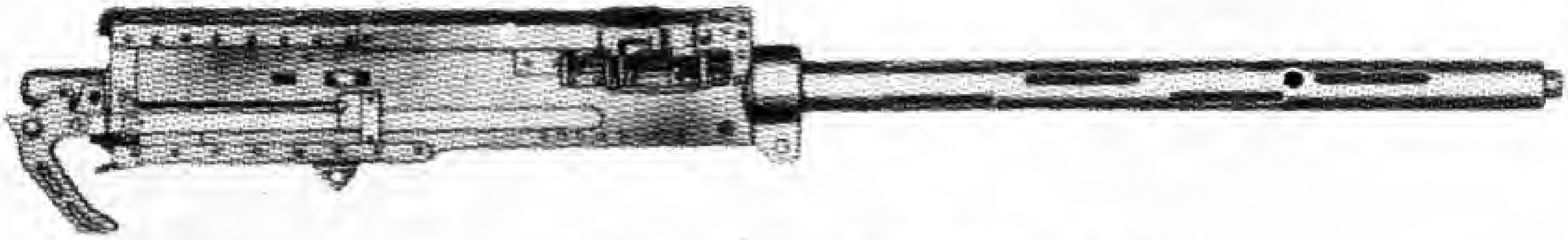
The M2-Heavy Barrel (M2-HB) was originally built to meet the needs of the U.S. Cavalry. The first M2-HB's had 36 inch barrels but these were lengthened to 45 inches before World War II.

During World War II, the M2 guns were produced by Colt's Patent Fire Arms Company, High Standard Company, Savage Arms Corporation, Buffalo Arms Corporation, Frigidaire, AC Spark Plug, Brown-Lipe-Chappin, Saginaw Division of General Motors Corporation, and the Kelsey Hayes Wheel Company. The initial cost of the Browning M2 machine gun was $750.00. Production ceased temporarily at the end of World War II. A total of about 2 million M2's were built with about 23 percent of those being M2-HB's.

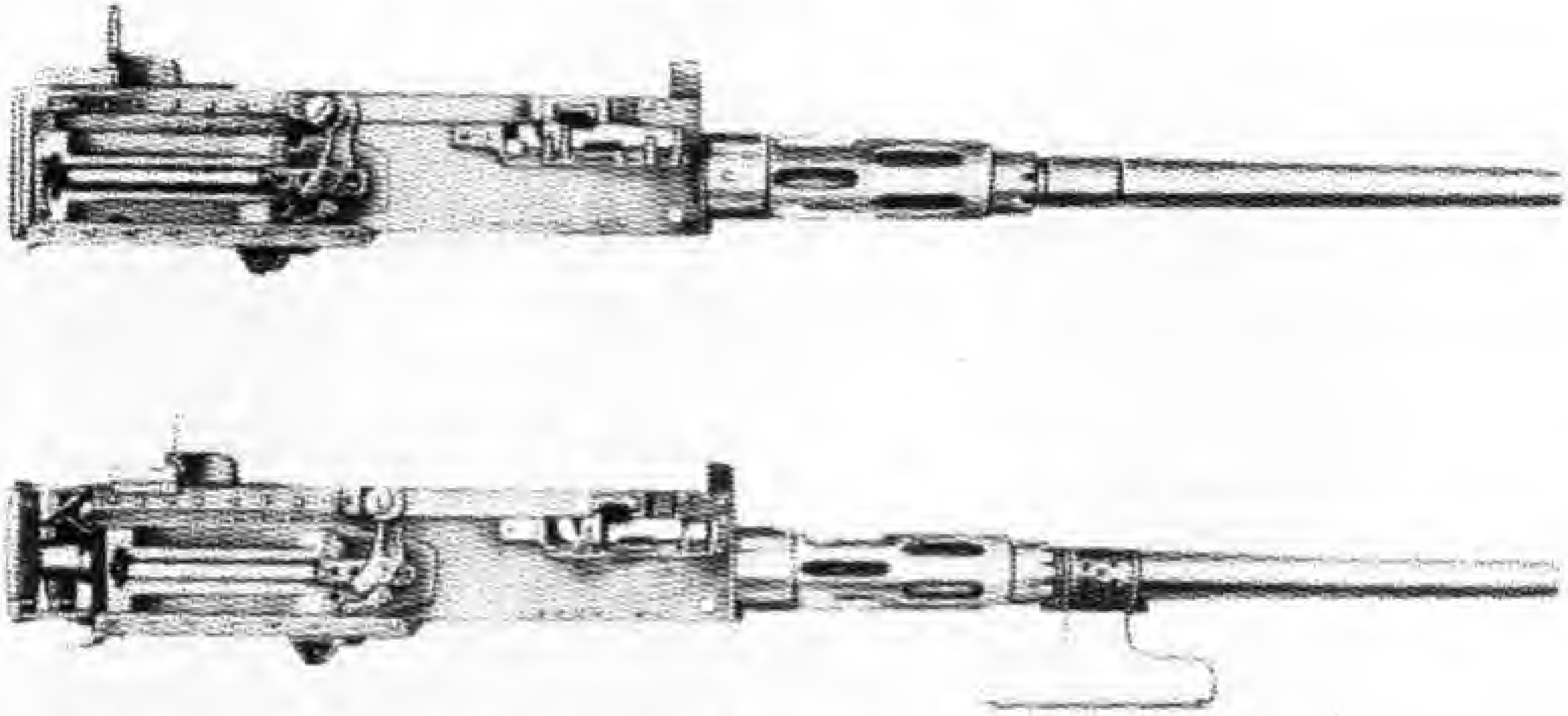
At least 21 different models of the calibre .50 Browning have been produced and the Japanese produced some much larger calibre versions during World War II. Since then, there has been further minor improvements and modifications to the guns and considerable improvements have been made in regard to barrel life. Production was resumed during the Vietnam War and continues today.

The M2-HB is still in service in the U.S. Army and Navy in various roles. The M85 tried and failed to replace it for tank mounts but the M2-HB is still more widely used.

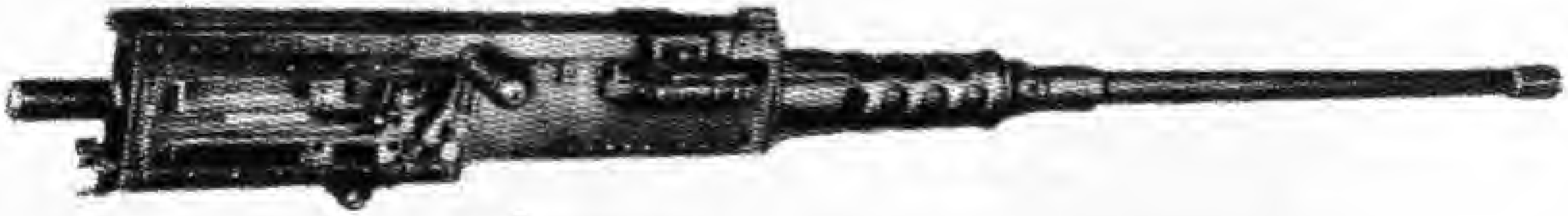
Since World War II there have been continuing efforts to replace the basic Browning Calibre .50 M2,



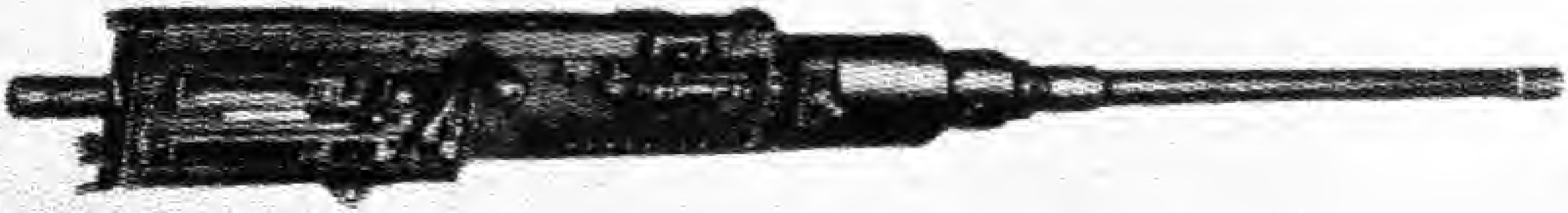
Browning Machine Gun - M2 Fixed



Browning Machine Guns - M2 - Heavy Barrel - Fixed & Flexible



Browning Machine Gun - M2 - Turret - with Barrel Support



Browning Machine Gun - M2 - Turret - with Edgewater Adapter

U.S. Calibre .50 Machine Guns

but to date there has been no success. The most notable attempts being the calibre .50, M85, numerous modification to improve the Hispano-Suiza, and the G.E. calibre .50.

Description and Purpose

The Browning Machine Gun, calibre .50, M2, aircraft basic, is a highly efficient automatic weapon built to precision standards. It is an air-cooled, alternate feed gun and, as such, may be fed from either the right or left side. It may be mounted on either a rigid or flexible mount. Manual cocking and loading of the gun is necessary before it is ready to function automatically. Then it may be fired by a mechanical or electrical accessory or by a manual trigger and trigger bar. While firing, all mechanical action is automatically performed by the gun itself and it will fire between 750 and 850 rounds per minute.

Characteristics

Weight of Gun	64 lbs.
Weight of Barrel	10 lbs.
Length of Barrel	36 in.
Number of Lands	8
Twist—Right Hand	1 turn in 15 in.
Overall Length of Gun	56.125 in.
Muzzle Velocity	2,750 fps (1,875 mi. per hr.)
Rate of Fire	750 to 850 rpm
Maximum Range	7,200 yds. (4.1 miles)

The M2-HB version of the Browning calibre .50 Heavy Barrel Machine Gun is a short-recoil operated, air cooled, single barrel link-belt fed weapon with adjustable headspace. Ammunition may be fed from either side by repositioning parts of the feed mechanism.

The M2-HB has been used on ground, tank, vehicle, and deck mounts as flexible machine gun and in turrets and multiple gun mounts with some parts changed or removed. The M2-HB weapon was originally built to give vehicles a weapon effective against other vehicles.

Cycle of Operation

The cycle of operation is broken down into eight basic steps. More than one step may occur at the same time. The steps are listed in the following order:

M2-HB Characteristics

Lengths:	
Weapon with Flash Hider	70 in.
Weapon without Flash Hider	65 in.
Barrel	45 in.
Barrel Rifling	42 in.
Sight Radius	20 in.
Number of Grooves and Twist of Rifling	8 (right hand)
Pitch of the Grooves	15 in.
Sights:	Rear sight with adjustable diopter in windage and graduated from 100 to 2,600 m. Front sight fixed.
Height	7.6 in.
Width	8.9 in.
Weights:	
Weapon	83 lb.
Barrel	28.6 lb.
Types of Firing	Semi-automatic and Automatic
Rates of Fire:	
Cyclic	450 to 550 rpm
Effective	150 rpm
Ejection:	
Cases	Downwards
Links to the right for left feed and vice versa	
Muzzle Velocity	2900 fps
Effective Range	1.2 mi.
Maximum Range	4.2 mi.
Operating Principles:	Short Recoil of the Barrel (30mm). Positively Locked - 2 Buffer Blocks (1 inside the buffer body and 1 inside the back plate).

(1) *Feeding.* Feeding is the action of placing a cartridge bolt in the feedway, with the double link forward.

(2) *Chambering.* The round is placed in the chamber.

(3) *Locking.* The bolt is locked to the barrel and barrel extension.

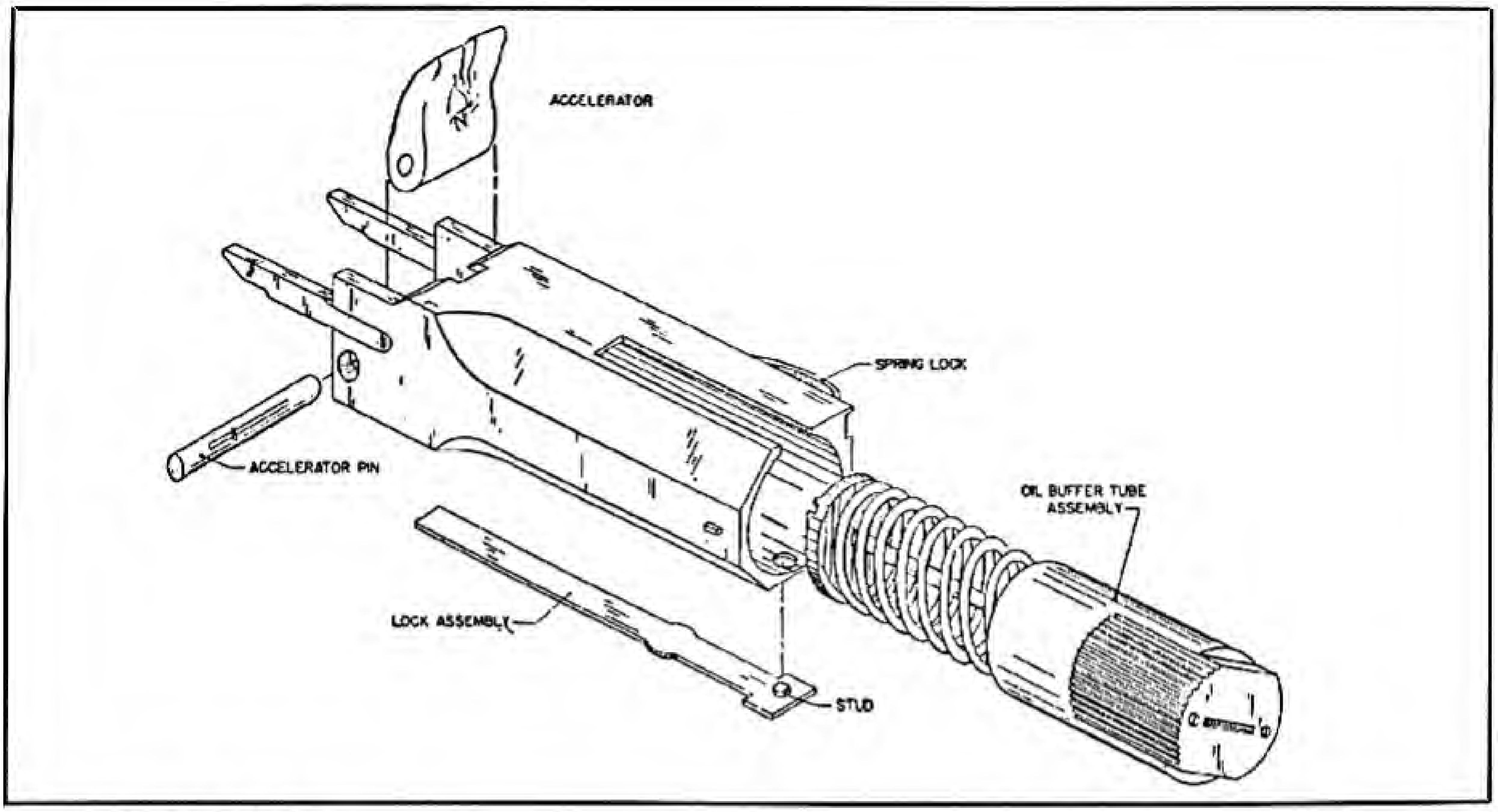
(4) *Firing.* The releasing of the firing pin, igniting the primer of the cartridge.

(5) *Unlocking.* The bolt unlocks from the barrel and barrel extension.

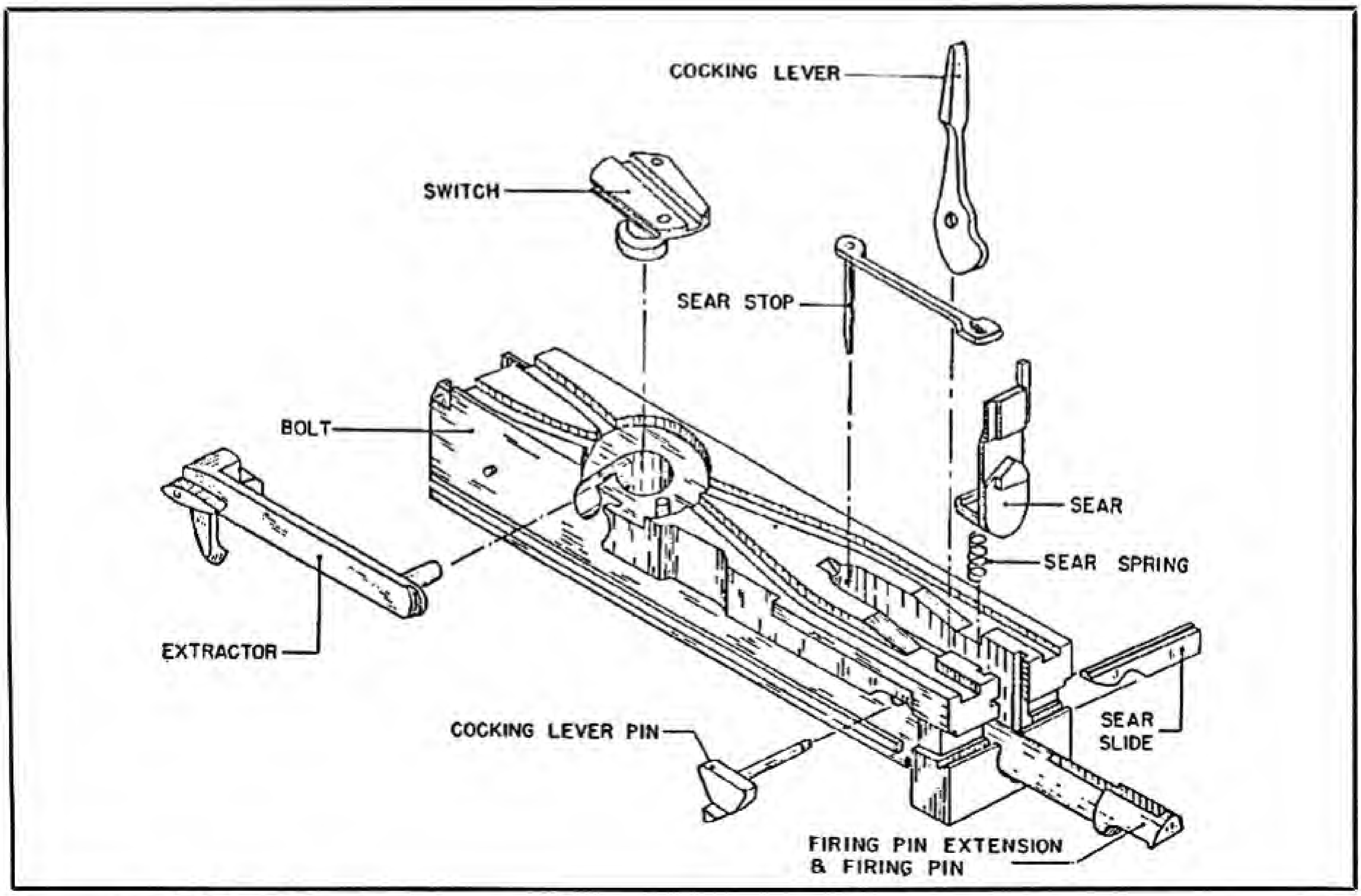
(6) *Extracting.* The empty cartridge case is pulled from the chamber.

(7) *Ejecting.* The empty cartridge case is ejected from the receiver.

(8) *Cocking.* The firing pin is withdrawn into the cocked position.


ACCELERATOR
SPRING LOCK
ACCELERATOR PIN
OIL BUFFER TUBE ASSEMBLY
LOCK ASSEMBLY
STUD

Disassembly of Bolt Group


COCKING LEVER
SWITCH
SEAR STOP
BOLT
SEAR
SEAR SPRING
EXTRACTOR
SEAR SLIDE
COCKING LEVER PIN
FIRING PIN EXTENSION & FIRING PIN

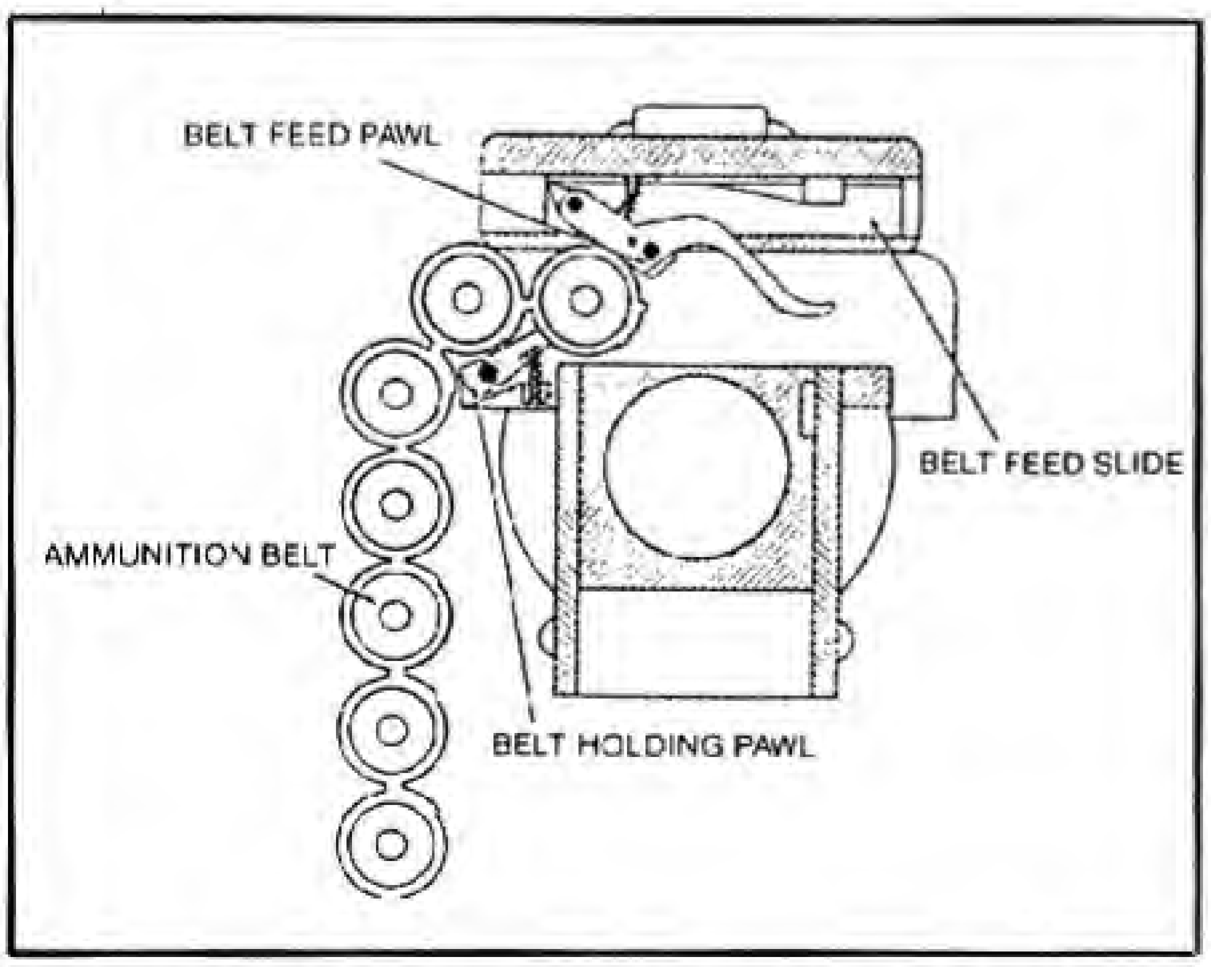
Disassembly of Oil Buffer Group

With the Browning machine gun, calibre .50 M2, the recoiling groups must be manually operated to place the first round in the chamber. The cycle of operation begins with the first round positioned over the belt holding pawl. The recoiling groups are now in their forward position.

When any cartridge is fired, the burning powder violently generates gas which, since it is confined by the cartridge case and barrel, exerts a tremendous pressure. This pressure reaches 50,000 pounds per square inch, and since this pressure pushes against the back face of the bullet, which up to this moment is still within the cartridge case and which has a diameter of one-half inch, a driving force of five tons pushes the bullet out of the barrel. This same force tries to drive the cartridge case out of the chamber toward the rear. Such action is prevented by having the bolt positively locked against the rear of the cartridge at the instant of firing.

When the cartridge is fired the force of recoil carries the barrel, barrel extension, and bolt (known as the recoiling portion) backward a short distance. This motion unlocks the bolt from the barrel and barrel extension, and the bolt throws back farther toward the rear against a spring. This spring serves to drive the bolt forward again. The empty case is withdrawn by the bolt from the barrel chamber and the next cartridge is extracted from the supply belt.

The long rearward motion of the bolt is checked and as it surges forward the empty case is ejected and the next cartridge is moved into the barrel chamber. The short, rearward motion of the barrel and barrel extension is checked by the oil buffer and its spring; this buffer spring serves to drive them forward again. This motion locks the bolt to the barrel, thus again preventing the case from being driven toward the rear. The last forward motion of the bolt and barrel causes the firing pin to strike the cartridge, providing a means of releasing the sear is furnished. This cycle continues as long as trigger action is maintained and as long as ammunition is supplied.



Feeding—Bolt Fully Forward, Belt Feed Slide in the Cover and Ammunition Belt held in the Feedway by the Belt Holding Pawl (rear view).

Feeding

a. Left-Hand Feed.

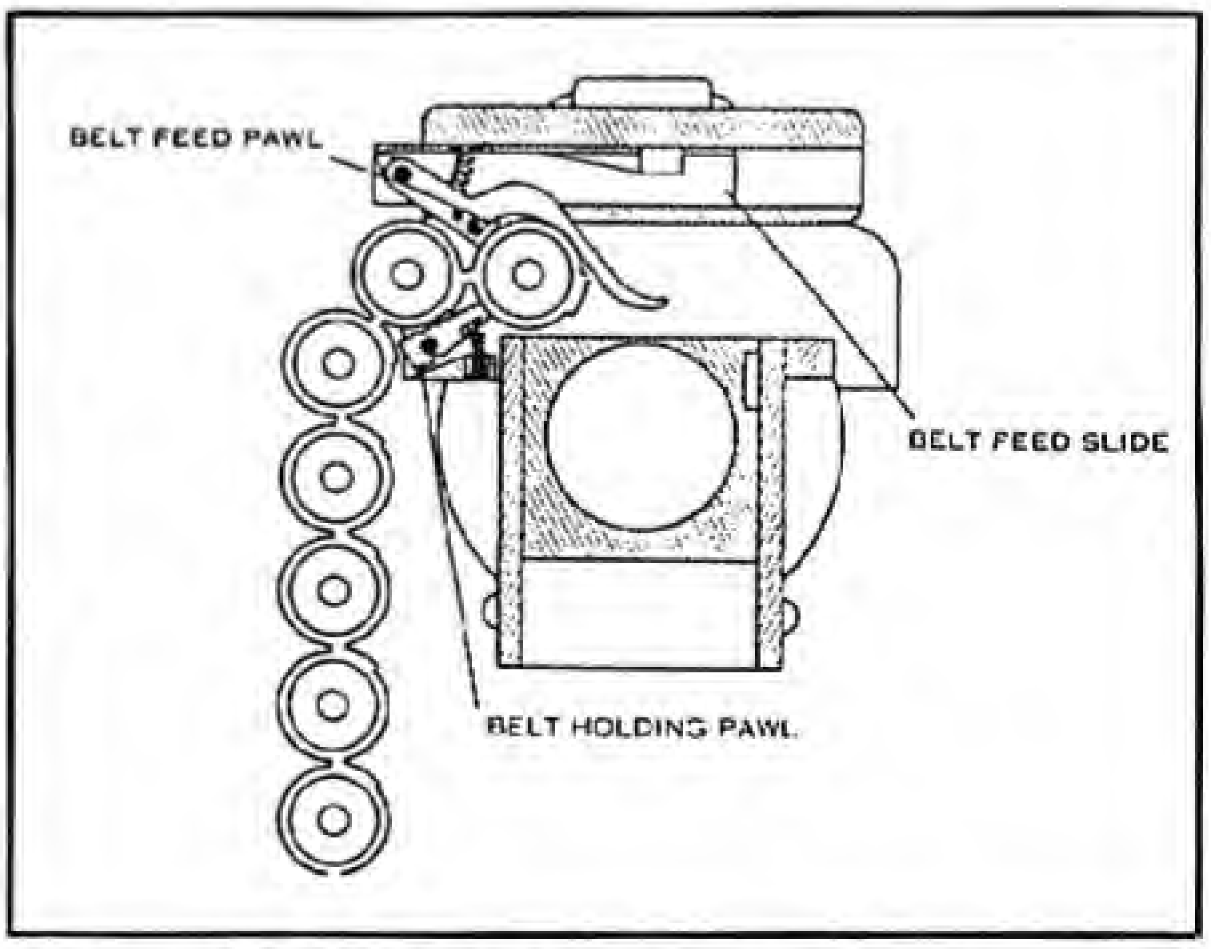
(1) When the bolt is fully forward, the belt feed slide is in the cover, and the ammunition belt is held in the feedway by the belt holding pawl.

(2) As the bolt moves to the rear, the cam grooves guide the belt feed lever, pivoting the lever and moving the slide out the side of the cover. The belt is held stationary by the belt holding pawl, while the belt feed pawl pivots, compressing its spring, and rides up over the link holding the first round.

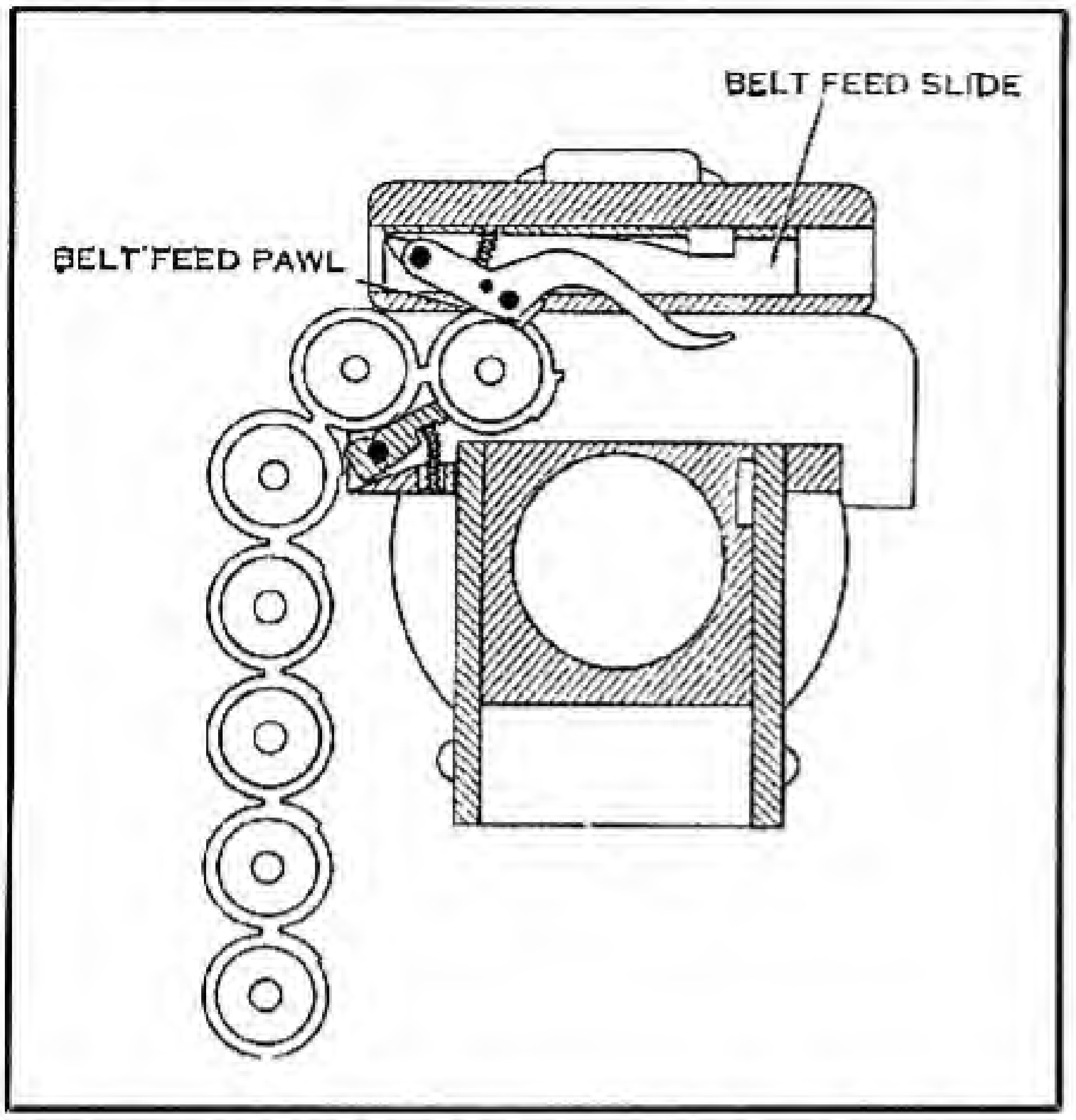
(3) When the bolt is all the way to the rear, the belt feed slide moves out far enough to allow the belt feed pawl spring to force the pawl down behind the first round.

(4) As the bolt moves forward, the belt feed lever moves the slide back into the receiver. The belt is pulled in by the belt feed pawl. The next round rides over the belt holding pawl, compressing its spring and forcing the pawl down until the round has passed over the pawl.

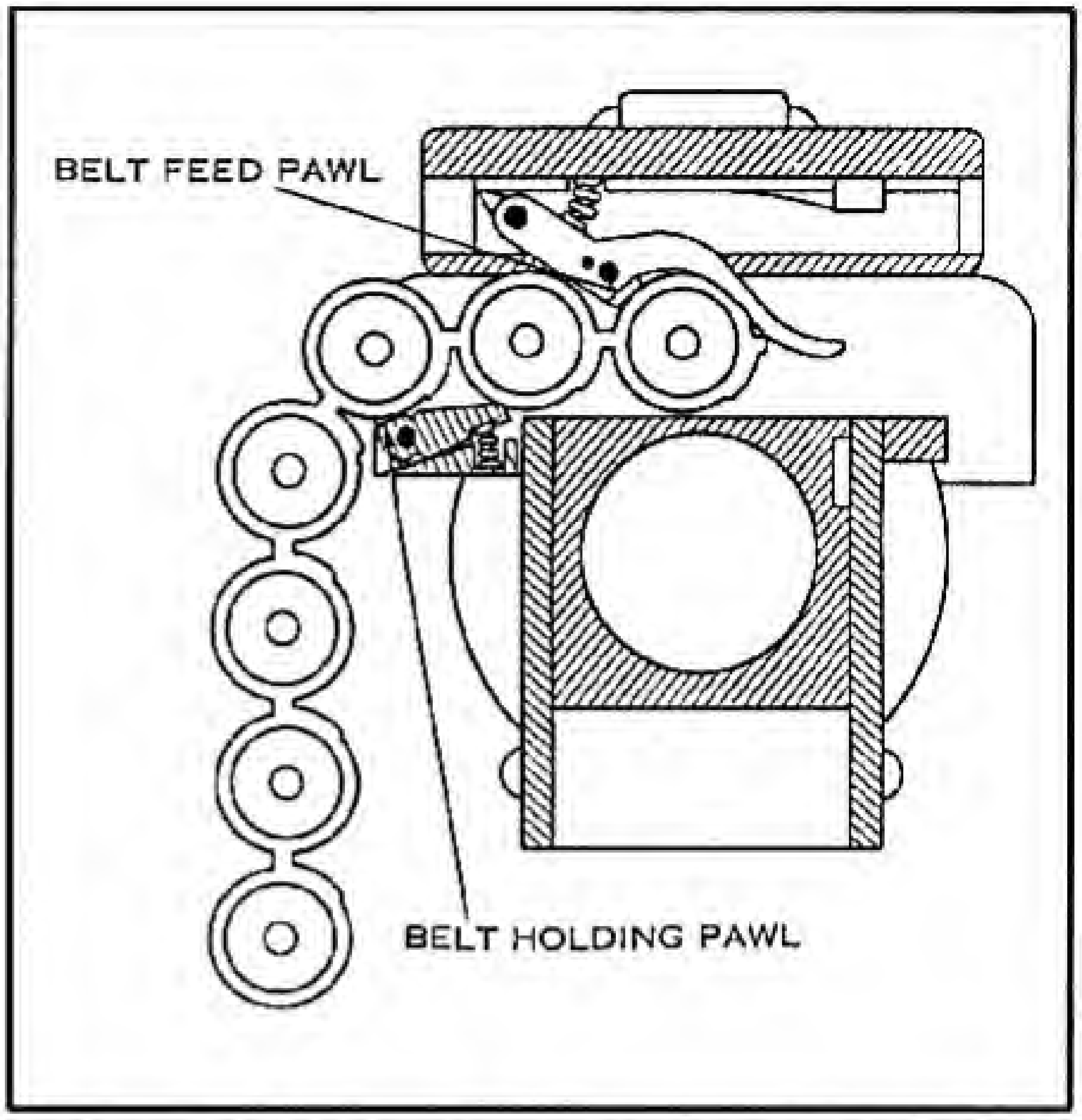
(5) When the bolt is fully forward, the slide is back in the cover, and the first round is engaged by the extractor.



Feeding—Belt Feed Pawl Behind the First Round.



Feeding—Belt Feed Pawl Riding over the First Round.



Feeding—Belt Feed Slide Moving Inside the Cover, with the Belt Feed Pawl Behind the First Round.

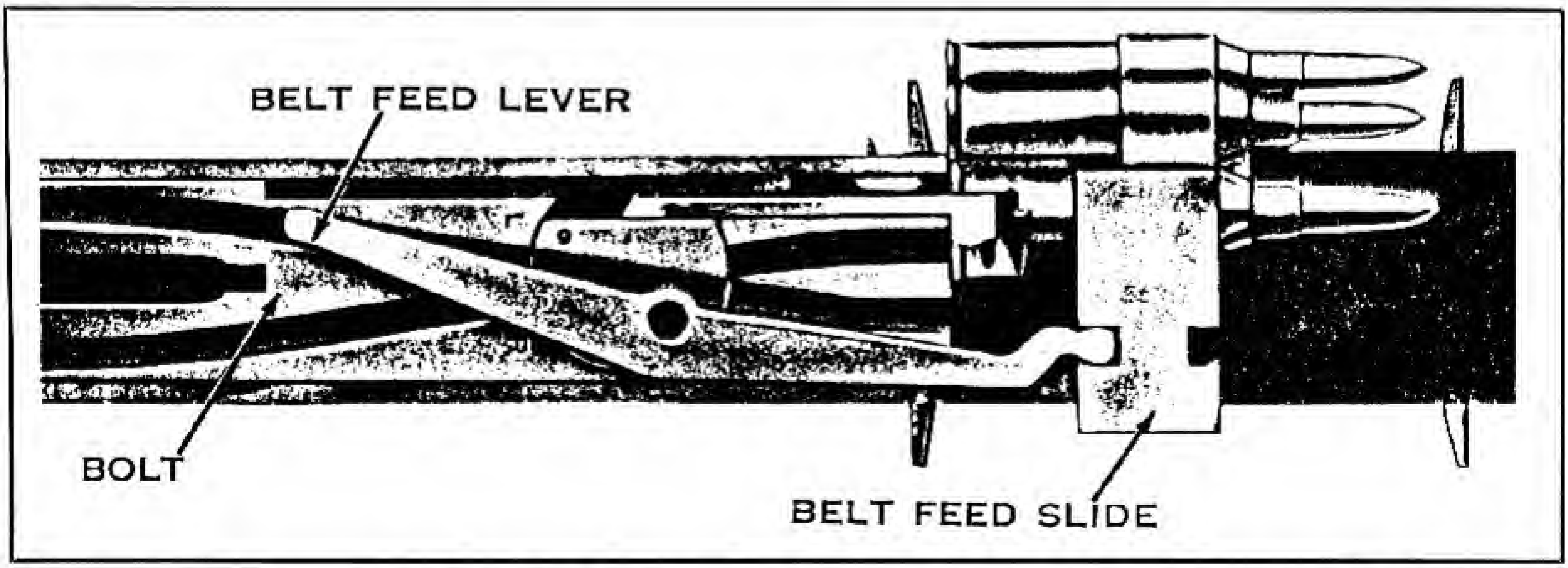
(6) If for any reason a round is not extracted from the belt, the belt feed pawl arm will ride up over the round, holding up the belt feed pawl to prevent double-feeding.

b. Withdrawing a Round from the Belt.

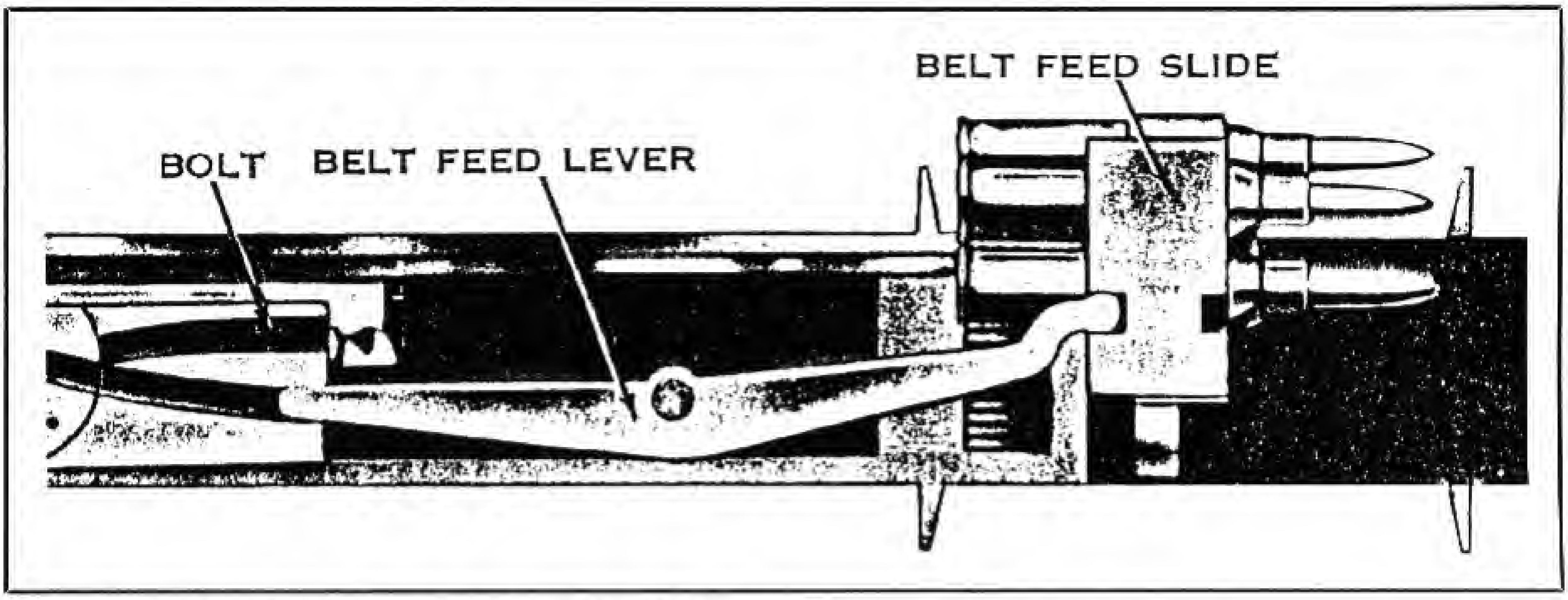
(1)The extractor grips the first round in the feedway and, as the recoiling parts move to the rear, withdraws it from the ammunition belt. Initially, the grip of the extractor is held secure by the downward pressure of the cover extractor spring.

(2) As the bolt continues its movement to the rear, the cover extractor cam forces the extractor down, causing the cartridge to enter the T-slot in the bolt.

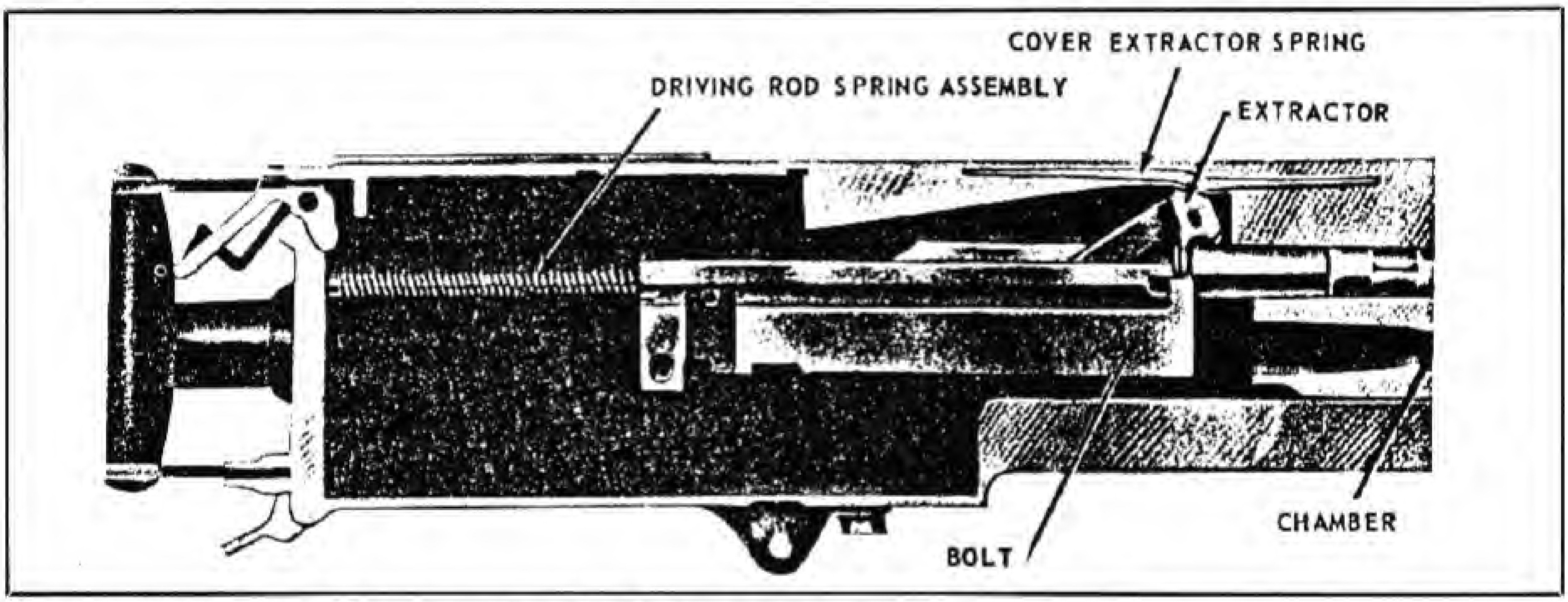
(3) As the bolt moves to the rear and the extractor is forced down, the extractor lug, riding along the top of the extractor switch, forces the rear end of the extractor switch downward. Near the end of the rearward movement, the extractor lug overrides the end of the switch and the switch snaps back up into position.



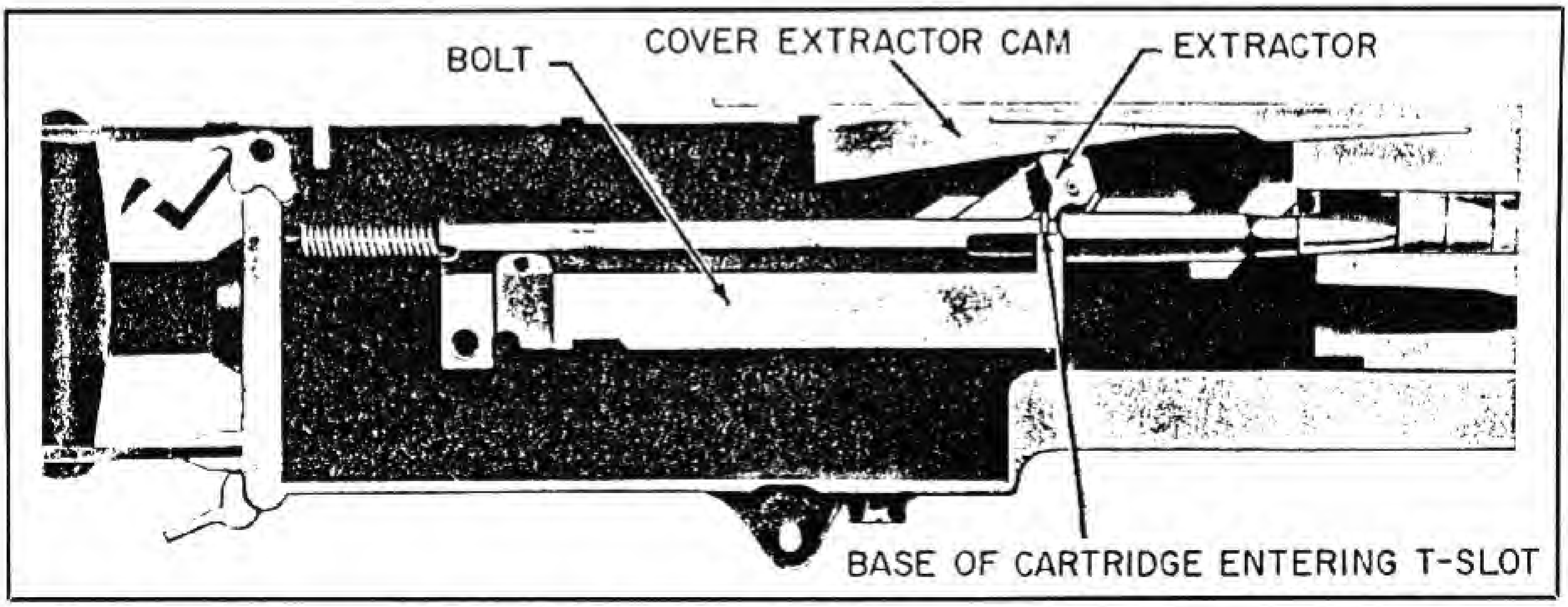
Feeding—Bolt Fully Forward, Belt Feed Slide in the Cover and Ammunition Belt held in the Feedway by the Belt Holding Pawl (top view).


BELT FEED SLIDE
BOLT
BELT FEED LEVER

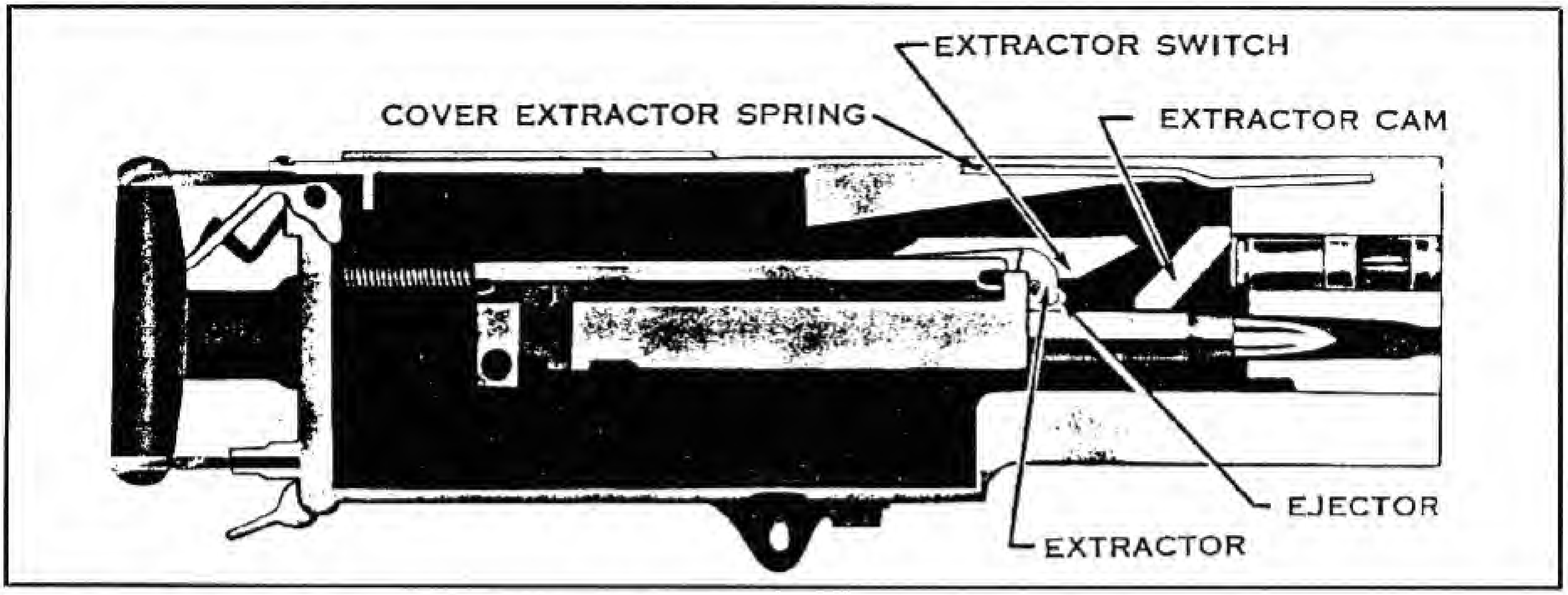
Feeding—Belt Feed Slide Moving out of the Side of the Cover.


COVER EXTRACTOR SPRING
DRIVING ROD SPRING ASSEMBLY
EXTRACTOR
CHAMBER
BOLT

Feeding—Withdrawing the First Round from the Feedway.


BOLT
COVER EXTRACTOR CAM
EXTRACTOR
BASE OF CARTRIDGE ENTERING T-SLOT

Feeding—Cartridge Entering the T-slot in the Bolt.



Chambering—New Round Aligned with the Chamber.

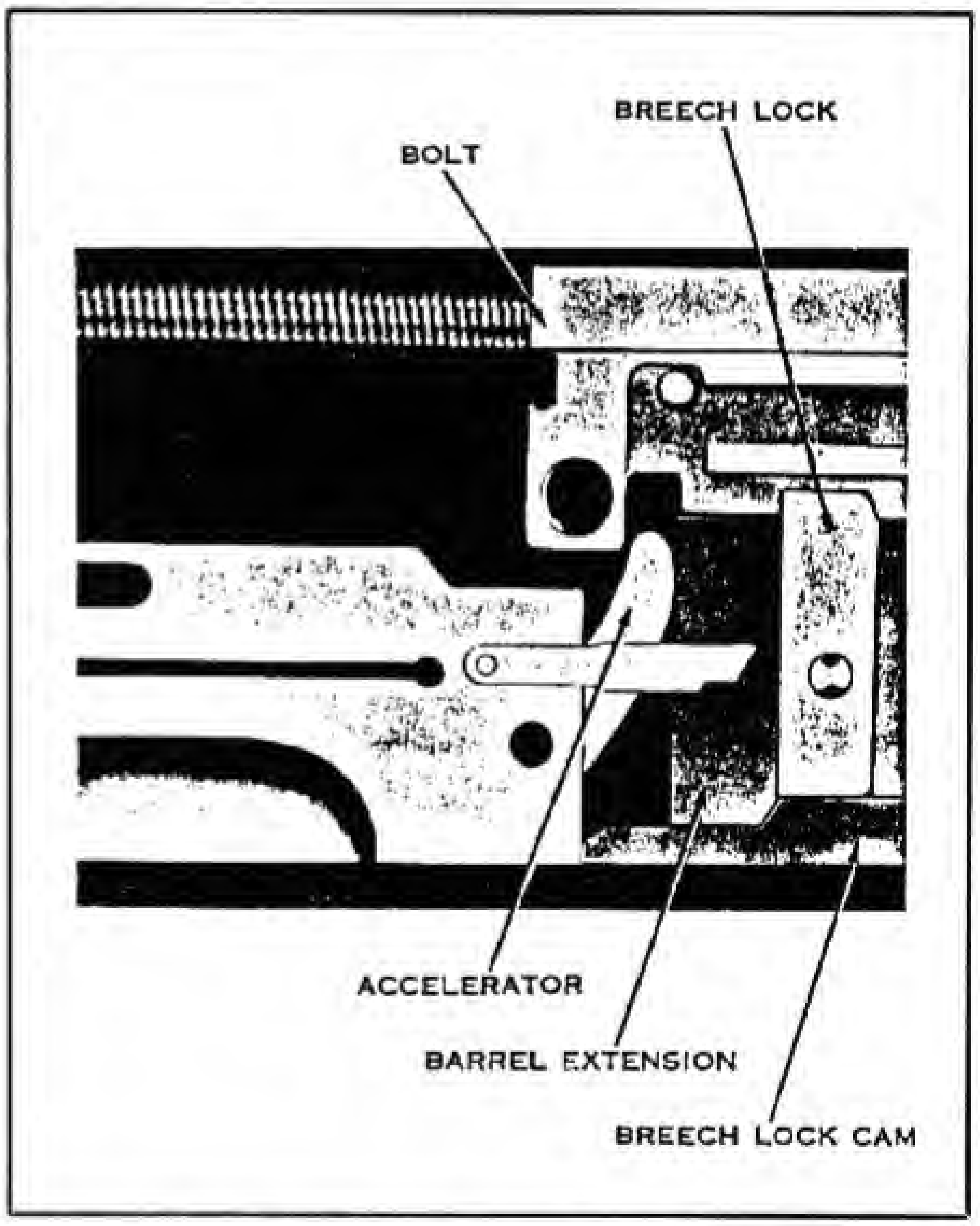
Chambering

As the bolt moves forward, the round is held by the T-slot and the extractor assembly. The extractor stop pin on the left side of the bolt permits the extractor assembly to go down only far enough to align the round with the chamber. As the bolt continues forward, the round is chambered. As this action takes place, the extractor lug rides up the extractor cam, compressing the cover extractor spring, and through the pressure of the spring, snaps into the groove in the next cartridge base.

Locking

a. Initially, the bolt is forced forward in counterrecoil by the energy stored in the driving spring assembly and the compressed buffer disks. At the start of counterrecoil, the barrel buffer body tube lock keeps the accelerator tips from bouncing up too soon and catching in the breech lock recess in the bolt. After the bolt travels forward about 5 inches, the lower rear projection of the bolt strikes the tips of the accelerator, turning the accelerator forward. This unlocks the barrel extension from the barrel buffer body group and releases the barrel buffer spring. The barrel buffer spring expands, forcing the piston rod forward.

b. Since the cross groove in the piston rod engages the notch on the barrel extension shank, the barrel extension and barrel are also forced forward by the action of the barrel buffer spring. Some of the forward motion of the bolt is transmitted to the barrel extension through the accelerator. As the accelerator rotates forward, the front of the accelerator speeds up the barrel extension; at the same, the accelerator tips slow down the bolt.



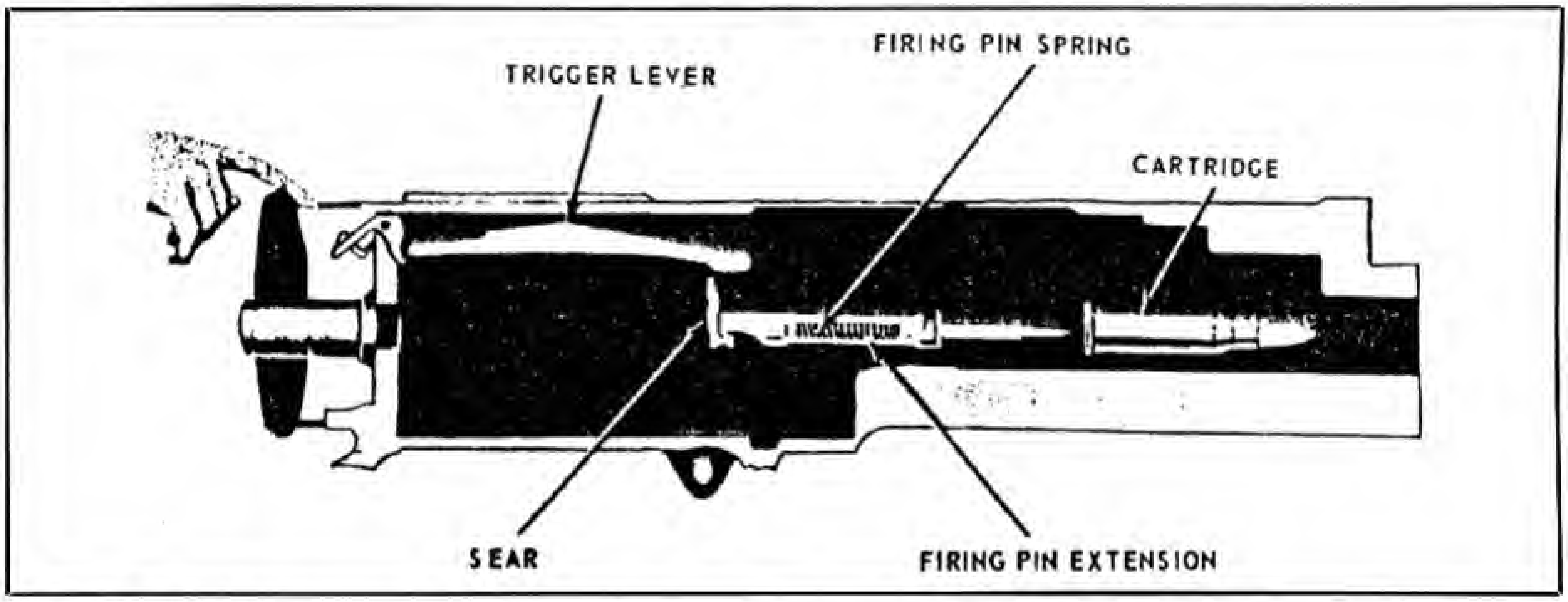
Locking—Recoiling Groups Locked Together.

c. Locking begins 1⅛ inches before the recoiling groups (bolt, barrel extension, and barrel) are fully forward. The breech lock in the barrel extension rides up the breech lock cam in the bottom of the receiver into the breech lock recess in the bottom of the bolt, locking the recoiling groups together. The recoiling groups are completely locked together three-fourths of an inch before the groups are fully forward.

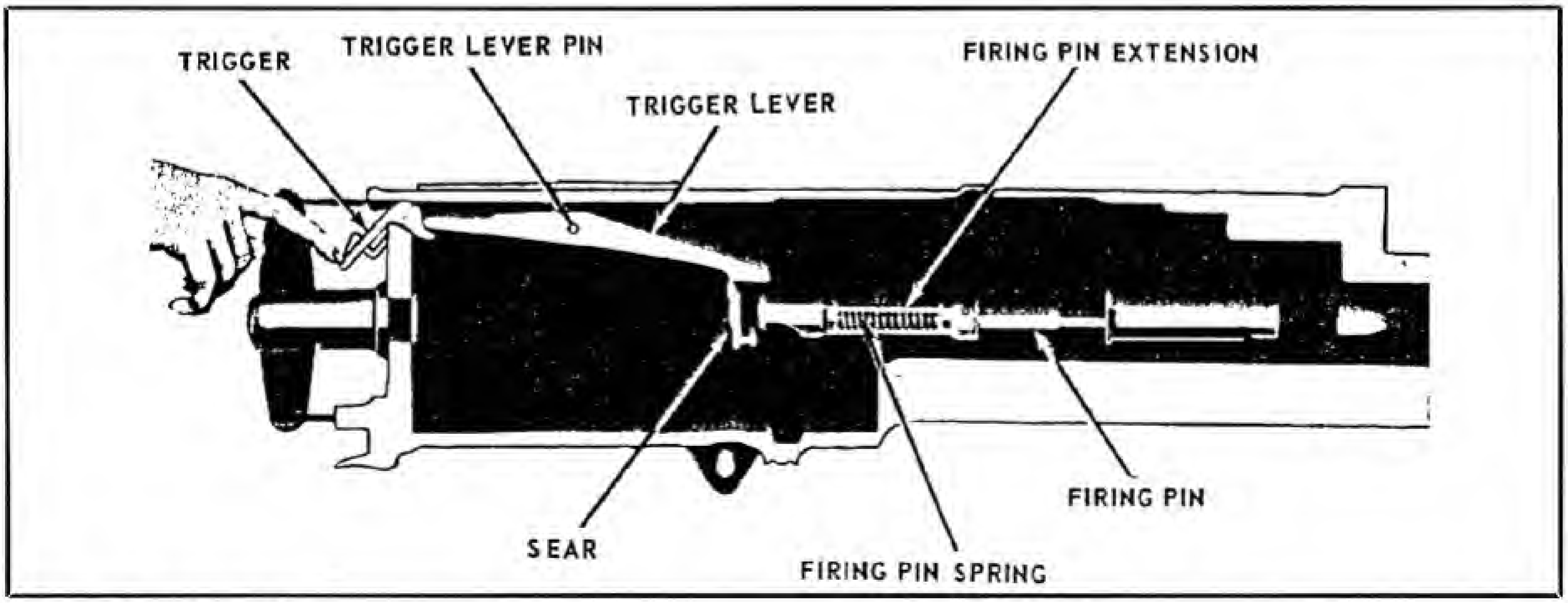
Firing

a. As the trigger is pressed down, it pivots on the trigger pin, so that the trigger cam on the inside of the backplate engages, and raises, the rear end of the trigger lever, which, in turn, pivots on the trigger lever pin assembly, causing the front end of the trigger lever to press down on the top of the sear stud. The sear is forced down until the hooked notch of the firing pin extension is disengaged from the sear notch. The firing pin and firing pin extension are driven forward by the firing pin spring; the striker of the firing pin hits the primer of the cartridge, firing the round.

b. For automatic firing, the bolt latch release must be locked, or held depressed, so that the bolt latch will not engage the notches in top of the bolt, holding the bolt to the rear, as in single-shot firing. The trigger is pressed and held down. Each time the bolt travels forward in counterrecoil, the trigger lever depresses the sear releasing the firing pin extension assembly and the firing pin, automatically firing the next round when the forward movement of the recoiling groups is nearly completed. The gun should fire about one-sixteenth of an inch before the recoiling groups are fully forward. At the instant of firing, the parts are in battery, i.e., the proper position for firing. Only the first round should be fired with the parts fully forward. The gun fires automatically as long as the trigger and bolt latch are held down, and ammunition is fed into the gun.



Firing—Ready to Fire.



Firing—Round Ignited.

Unlocking

a. At the instant of firing, the bolt is locked to the barrel extension and against the rear end of the barrel by the breech lock, which is on top of the breech lock cam and in the breech lock recess in the bottom of the bolt.

b. When the cartridge explodes, the bullet travels out of the barrel; the force of recoil drives the recoiling groups rearward. During the first three-fourths of an inch, the recoiling groups are locked together. As this movement takes place, the breech lock is moved off the breech lock cam stop, allowing the breech lock depressors (acting on the breech lock pin) to force the breech lock down, out of its recess from the bottom of the bolt. At the end of the first three-fourths of an inch of recoil, the bolt is unlocked, free to move to the rear, independent of the barrel and barrel extension.

c. As the recoiling groups move to the rear, the barrel extension causes the tips of the accelerator to rotate rearward. The accelerator tips strike the lower rear projection of the bolt, accelerating the movement of the bolt to the rear.

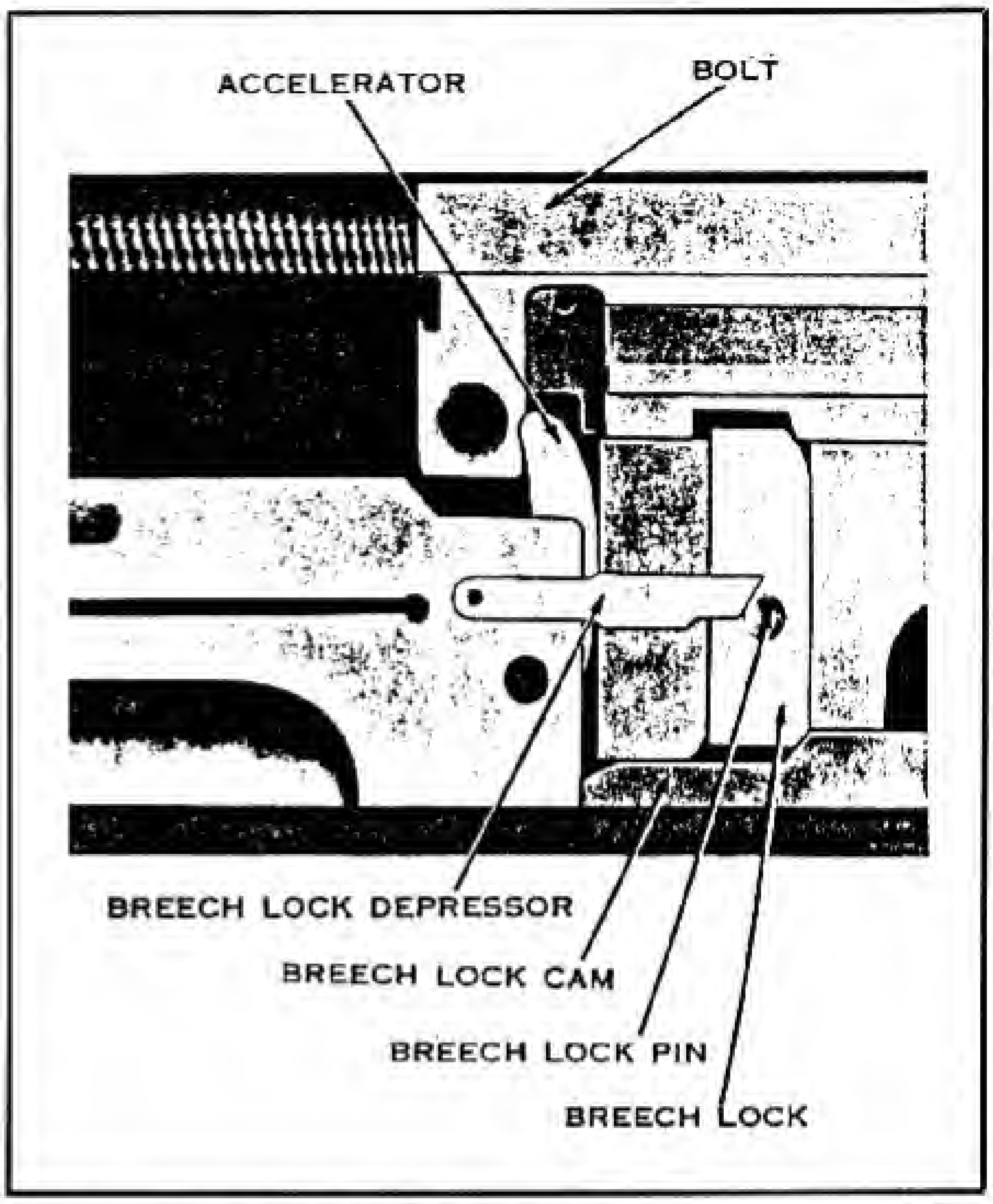
d. The barrel and barrel extension continue to travel to the rear an additional three-eighths of an inch, or an approximate total distance of 1⅛ inches, until they are stopped by the barrel buffer assembly.

e. During the recoil of 1⅛ inches, the barrel buffer spring is compressed by the barrel extension shank, since the notch on the shank is engaged in the cross groove in the piston rod head. The spring is locked in the compressed position by the claws of the accelerator, which engage the shoulders of the barrel extension shank.

f. After its initial travel of three-fourths of an inch, the bolt travels an additional 6⅜ inches to the rear, after it is unlocked from the barrel and barrel extension, for a total of 7⅛ inches. During this movement, the driving springs are compressed. The rearward movement of the bolt is stopped as the bolt strikes the buffer plate. Part of the recoil energy of the bolt is stored by the driving spring rod assembly, and part is absorbed by the buffer disks in the backplate.

Extracting

a. The empty case, held by the T-slot, has been expanded by the force of the explosion; therefore, it fits snugly in the chamber. If the case is withdrawn from the chamber too rapidly, it may be torn. To prevent this, and to insure slow initial extraction of the case, the top forward edge of the breech lock and the forward edge of the lock recess in the bolt are beveled. As the breech lock is unlocked, the initial movement of the bolt away from the barrel and barrel extension is gradual.



Unlocking—Breech Lock Being Forced out of its Recess in the Bolt.

b. The slope of the locking faces facilitates locking and unlocking and prevents sticking. The leverage of the accelerator tips on the bolt speeds extraction, after it is started, by kicking the bolt to the rear to extract the empty case from the chamber.

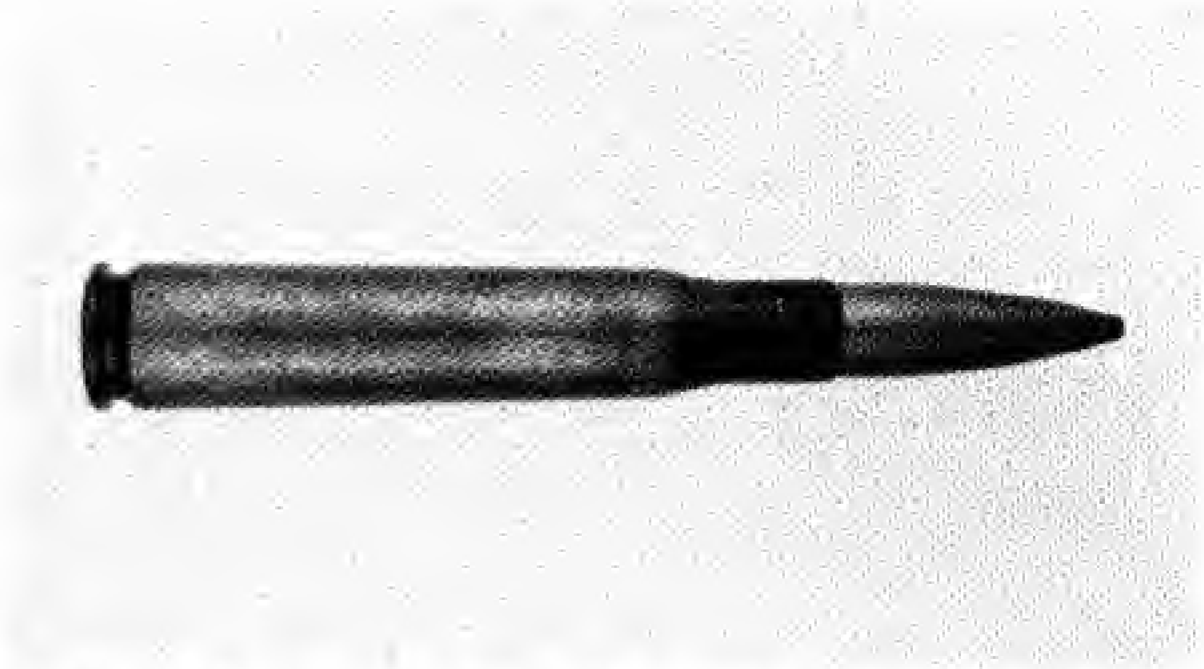
Ejecting

As the bolt starts its forward movement (counter-recoil) the extractor lug rides below the extractor switch, forcing the extractor assembly farther down, until the round is in the center of the T-slot. The round, still gripped by the extractor, ejects the empty case from the T-slot. The last empty case of an ammunition belt is pushed out by the ejector.

Cocking

a. When the recoiling groups are fully forward, the top of the cocking lever rests on the rear half of the V-slot in the top plate bracket. As the bolt moves to the rear, the top of the cocking lever is forced forward. The lower end pivots to the rear on the cocking lever pin. The rounded nose of the cocking lever, which fits through the slot in the firing pin extension, forces the extension to the rear, compressing the firing pin spring against the sear stop pin (accelerator stop).

b. As the firing pin extension is pressed to the rear, the hooked notch of the extension rides over the sear notch, forcing the sear down. The sear spring forces the sear back up after the hooked notch of the firing pin extension has entered the sear notch. The pressure of the sear and firing pin spring holds the two notches locked together. There is a slight overtravel of the firing pin extension in its movement to the rear, to insure proper engagement with sear. As the bolt starts forward, the overtravel is taken up and completed when the cocking lever enters the V-slot of the top plate bracket, and is cammed towards the rear; pressure on the cocking lever is relieved as the bolt starts forward.



Calibre .50 Browning Cartridge (Photo courtesy of Woodin Laboratories). Also used in the T42, T176, T164, GAU-6, GECAL .50 and the M85.

SECTION II.

CALIBRE .50 AN-M3 SERIES MACHINE GUN

U.S. ARMY ORDNANCE CORPS

Description

The calibre .50 basic aircraft machine gun AN-M3 is an automatic, recoil-operated, link-belt-fed, air-cooled machine gun having a rate of fire over 1000 rounds per minute. A metallic link disintegrating belt is used to hold the ammunition while it is being fed into the gun. By changing the position of some of the component parts, the gun may be set up so that the ammunition can be fed from either the left- or right-hand side.

The gun is similar in general appearance to the calibre .50 basic aircraft Browning machine gun AN-M2.

The gun can be mounted in the wing or fuselage of a fighter plane. It may also be mounted in a turret of a bomber.

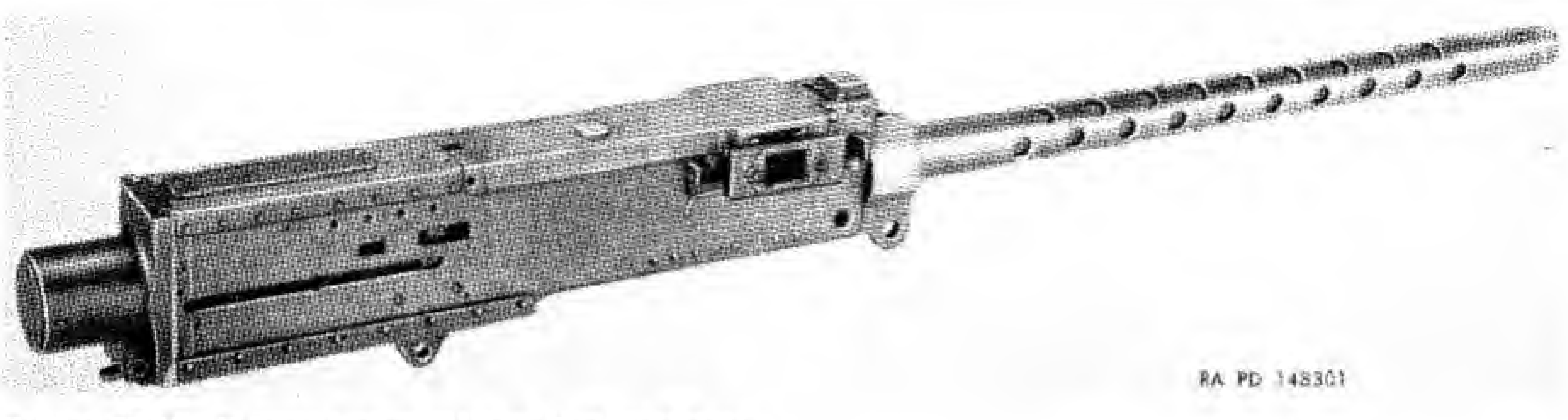
The gun fires percussion type primed ammunition. A solenoid, which can be mounted on the top plate or on either side of the gun depending upon what side the sear slide is assembled, is used to fire the gun.

Although the calibre .50 basic aircraft machine gun AN-M3 is similar in general appearance and functioning to the calibre .50 basic aircraft machine gun AN-M2, many of the components are *not* interchangeable between these two weapons.

Cycle of Operation

Cyclic functioning of the calibre .50 basic aircraft machine gun AN-M3 is identical with that of the calibre .50 basic aircraft Browning machine gun AN-M2. The barrel buffer of the gun AN-M3 takes the place of, and function in the same general manner as, the oil buffer of the gun AN-M2. In the barrel buffer of the gun AN-M3, the washer springs and air compression feature take the place of the oil and valve system of the oil buffer of the gun AN-M2.

The complete cycle of the recoiling parts of the gun, which takes place as each cartridge is fired,



Calibre .50 AN-M3 Basic Aircraft Machine Gun (right side).

consists of the recoil movement when certain parts move rearward, and the counterrecoil movement when the same parts move forward. At the instant of firing the first shot, the barrel, barrel extension, and the bolt, known as the recoiling parts, are in the fully forward or "battery" position in the gun.

At this time, the bolt is locked to the barrel extension and held securely against the rear of the cartridge in the chamber of the barrel by the breech lock, which extends up from the barrel extension into a notch in the underside of the bolt. The breech lock is held up by the breech lock cam upon which it rests.

After the cartridge explodes, and as the bullet travels out of the barrel, the force of recoil drives the recoiling parts rearward. During the first five-eighths inch of rearward travel, the breech lock is moved off the breech lock cam step. This permits the breech lock to be forced down out of the notch in the bolt by the breech lock depressors engaging the breech lock pin. This unlocks the bolt from the barrel extension.

As the recoiling parts move toward the rear, the barrel extension bears against the accelerator and rotates it rearward. The tips of the accelerator strike the lower projection on the bolt and accelerate the bolt to the rear.

The barrel and barrel extension have a total rearward travel of 1⅛ inches, at which time they are completely stopped by the barrel buffer body.

During this recoil of 1⅛ inches, the buffer spring in the barrel buffer is compressed by the rearward movement of the barrel extension, transmitted through the barrel extension shank to the buffer piston rod with which it is engaged. The spring is held in the compressed position by the barrel extension, locked by the claws of the accelerator which are moved against the shoulders of the barrel extension shank. The buffer spring assists the barrel buffer piston in bringing the barrel extension to rest during the recoil movement.

During recoil, the barrel buffer piston is forced from the forward end of the barrel buffer tube to the rear, compressing the air confined in the tube to the rear of the piston. The piston starts rearward rapidly due to an air port or hole in the wall of the barrel buffer tube within which it moves. The ports allows some air in the tube to escape quickly at the start of the rearward movement of the piston. As the piston moves beyond the port, the remaining air in the tube is gradually compressed thus forming a cushion. As the compression increases, the compressed air escapes into the piston through a spring-operated relief valve in its rear end. The escaped air then passes through the piston and out of the buffer tube through the enlarged rod hole in the tube cap. The valve regulates the flow of escaping air so that the rearward movement of the barrel extension and barrel is decelerated gradually. The opening of the relief valve is controlled by a coil spring seated in a retainer in the piston. The retainer is held in place by 10 cupped washer springs assembled in the piston, which bear upon the retainer and the rear face of the piston rod and act as a cushion for the rod at the end of the rearward movement. No terminal shock is transmitted to the buffer piston pin or piston rod due to the elongation of the pin hole in the rod.

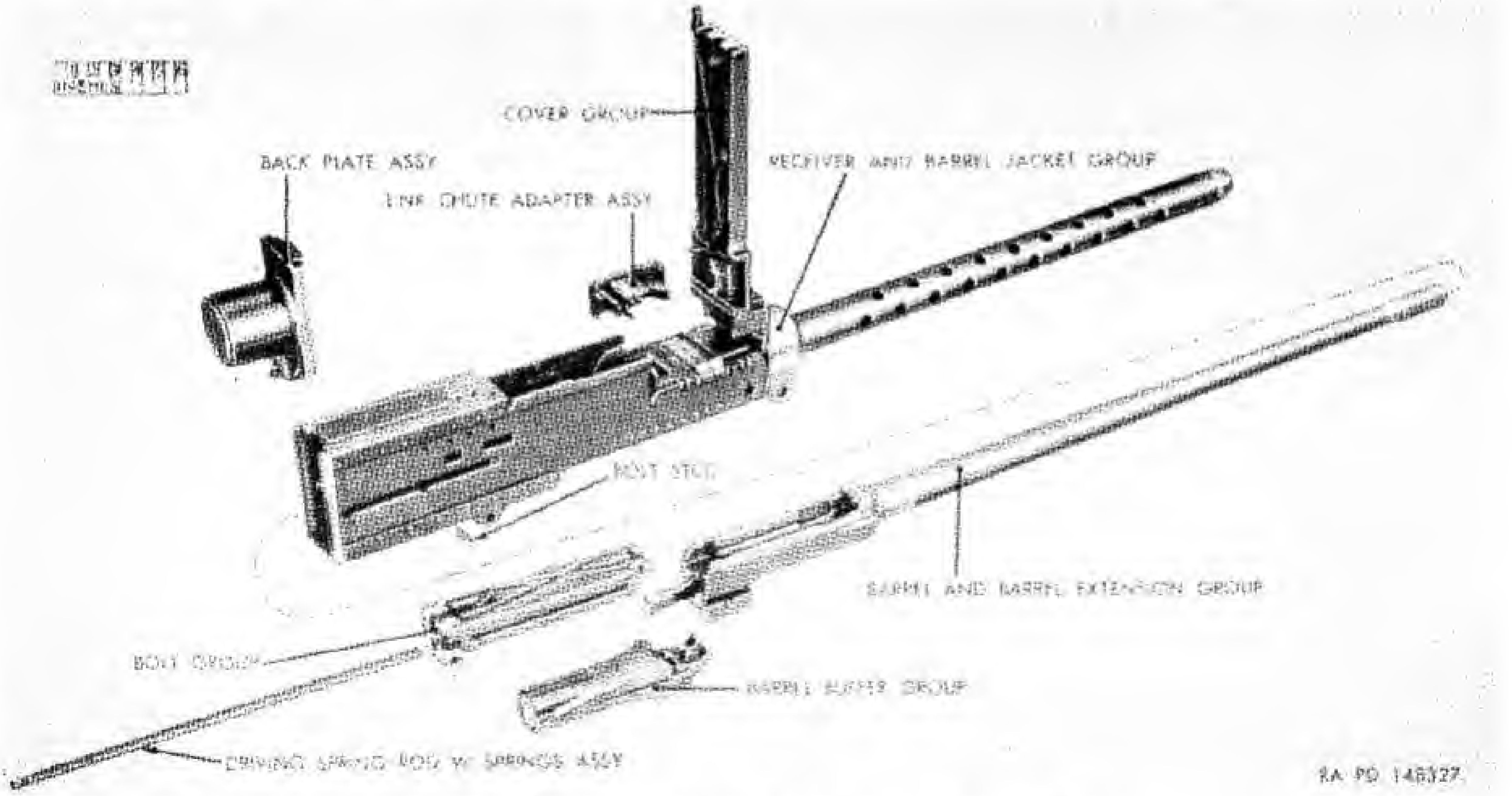
The bolt travels rearward compressing the buffer washer springs in the back place. During this travel, the driving springs are compressed. The rearward movement of the bolt is finally stopped as the bolt strikes the buffer plate in the back plate. Thus, part of the recoil energy of the bolt is stored in the driving springs, and part is absorbed and stored by the cupped washer springs upon which the buffer plate bears, in the back plate tube. Any remaining recoil energy is transmitted to the recoil adapter of the gun or to the gun mountings.

After completion of the recoil movement, the bolt is forced forward by the energy stored in the driving springs and the compressed back plate buffer washer springs. When the bolt has moved forward about 5¾ inches, the projection on the bottom of the bolt strikes the tips of the accelerator and rotates it forward. This rotation moves the claws of the accelerator away from the shoulders of the barrel extension shank. This releases the barrel buffer spring. The energy stored in the spring, supplemented by the counterrecoil energy of the bolt transmitted through the accelerator, forces the barrel and barrel extension forward.

No restriction to the forward motion of the barrel and barrel extension is desired; therefore, on the forward movement, the air ahead of the piston in the barrel buffer tube is allowed to escape through the enlarged hole in the tube cap through which the piston rod passes. As the piston nears its forward position, the air port in the tube is uncovered, allowing air to enter the rear end of the tube and relieve the vacuum created by the forward movement of the piston.

Note: Air is permitted to leave and enter the port in the barrel buffer tube through a longtitudinal groove in the tube. This groove extends from the port to the rear end of the tube.

As the barrel extension moves forward, the breech lock engages the sloping ramp of the breech lock cam and is forced upward. The bolt, which has been continuing its forward motion since striking the accelerator, has at this instant reached a position where the notch in the underside of the bolt is directly above the breech lock, permitting the breech lock to enter the notch and engage the bolt. Thus, the bolt is locked to the barrel extension just before the recoiling parts reach the firing position.

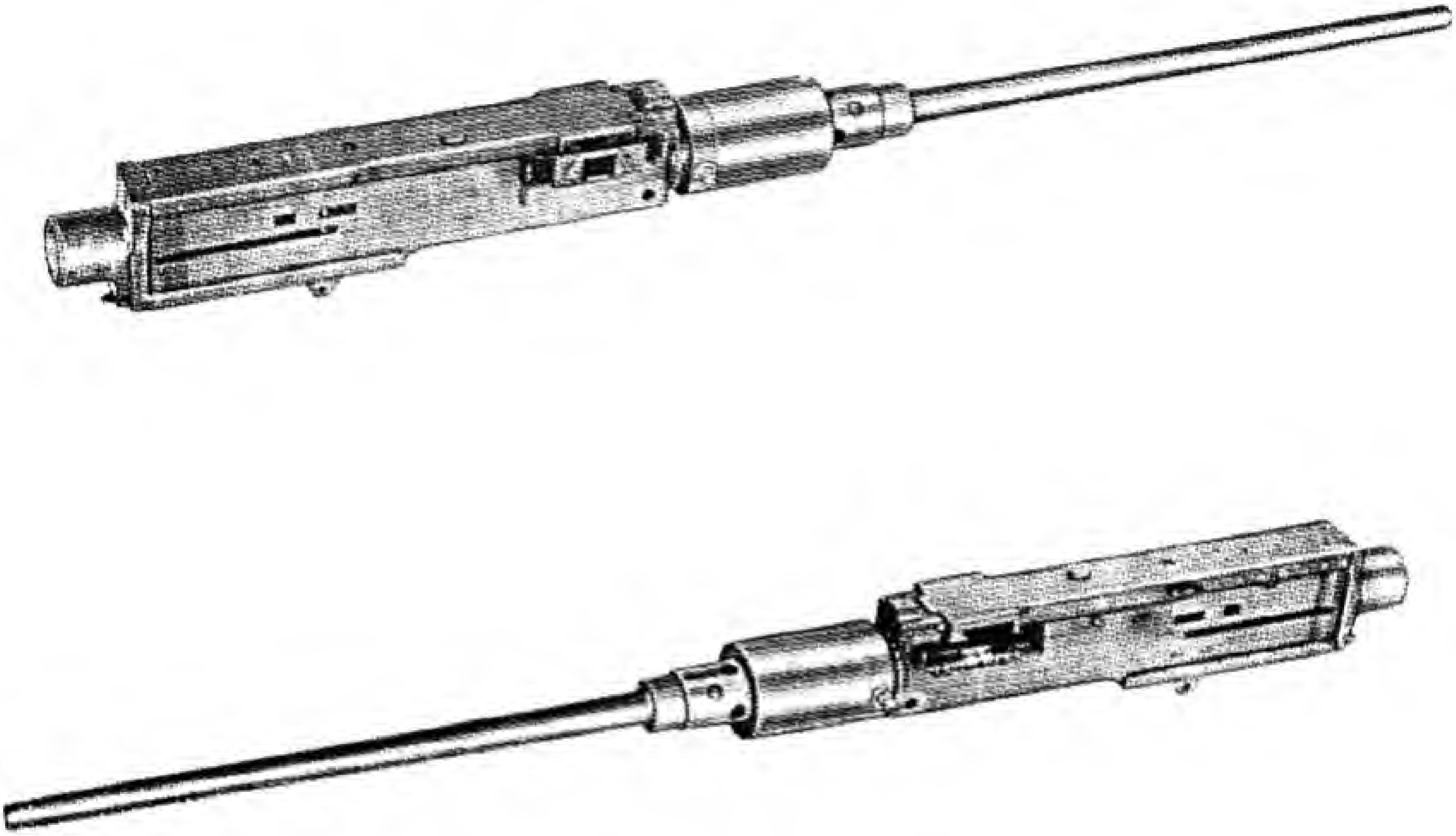

COVER GROUP
BACK PLATE ASSY
LINK CHUTE ADAPTER ASSY
RECEIVER AND BARREL JACKET GROUP
BOLT STOP
BARREL AND BARREL EXTENSION GROUP
BOLT GROUP
BARREL BUFFER GROUP
DRIVING SPRING ROD W/ SPRINGS ASSY
RA PD 148327

Relationship of Groups and Assemblies for Calibre .50 AN-M3 Basic Aircraft Machine Gun

SECTION III.

CALIBRE .50 T42 SERIES MACHINE GUN

U.S. ARMY ORDNANCE CORPS



T42 Calibre .50 Series Machine Gun

History

The development of the T42 calibre .50 machine gun began in September 1945 as part of a project to increase the effectiveness of the M2-HB calibre .50 machine gun. It was fabricated by using the receiver and gun mechanism of an AN-M3 calibre .50 basic machine gun with a barrel heavier than its standard 10.91 pound barrel but lighter than the 28 pound barrel of the M2-HB machine gun. Tests showed that the T42 had a rate of fire of 750 rounds per minute, which was more than that of the M2 but less than that of the AN-M3.

Work on the T42 progressed slowly until the Korean Conflict began and the need for a better tank machine gun became obvious.

In 1951 the U.S. Army Ordnance Corps initiated a program to develop a dual purpose calibre .50 tank machine gun. The desire was to develop a replacement for the calibre .50 Browning M2-HB for use in armored vehicles. This program had the goal of overcoming at least three short-comings of the Browning. Those were the excessive receiver length (a problem in the confines of a turret), the too low rate of fire for antiaircraft use, and the difficult adjustment of head space. Therefore, the specifications called for a weapon with, among other characteristics, selectable rates of fire (400 rpm for use against ground targets and 1050 rpm for use against aircraft), as short a receiver as possible, and fixed headspace.

Four different weapons were approved for limited development: the T175 short recoil operated with dual loding flaps; the T176 short recoil with rotating bolt loding; the T164 gas operated revolver gun; and the T42.

The T42 was tested in 1953 along with the M2-HB and AN-M3 machine guns. These tests showed that the T42 was reliable but inaccurate.

The Ordnance Corp knew of defects in the T42 and work began immediately to fabricate a new model, the T42E1, which would eliminate the defects.

The development of the T42E1 continued until January 1955, when a conference was held to discuss the program. Since there was insufficient time and money available to continue to investigate a number of different approaches to the goals of the program, the conference members concluded that development should continue only with the designs which could meet the requirements which had been established in 1950. Since the chief advantage of the T42 over the M2-HB was a slightly higher rate of fire, the conference recommended that work cease on its further development. This was certainly done because the T42E1 did not meet the 1950 requirements even though it was an improvement over the M2-HB machine gun in several respects. Its headspacing adjustment could be made by one man more easily than two could make the adjustment on an M2-HB. The rate of fire was increased from 450-550 rounds per minute to 650 for the T42E1. The barrel of the T42E1 weighed less and the new gun had an improved manual charger, a better flash suppressor, and a more durable barrel carrier. Accordingly, the T42 project was terminated in July 1955.

Description and Purpose

The last version of the T42 series, the M42E1, consisted of an AN-M3 calibre .50 basic aircraft machine gun receiver with a satellite-lined, chrome-plated barrel weighing 23.3 pounds. The total weight of the gun was approximately 76 pounds, and its overall length, with a flash suppressor, was 64.125 inches. It had a rate of fire of 650 rounds per minute and a maximum range of 6,470 yards. Air-cooled, recoil-operated, alternate-belt-fed, and manually charged, the T42 could be fired either by a manual trigger or by an internal electrical trigger. For flexible use, the T42E1 had spade grips that could be removed. The gun fired standard calibre .50 ammunition.

The original purpose of the gun was to be an improvement on the M2-HB with regard to a higher rate of fire.

Cycle of Operation

The operation of the T42E1 calibre .50 machine gun is similar to that of all Browning recoil-operated machine guns. When the trigger is depressed, the sear is forced downward until it is disengaged from the firing-pin extension. This releases the compressed firing-pin spring, which then drives the firing pin and firing-pin extension forward to fire the cartridge.

At the moment the cartridge is fired, the bolt is locked to the barrel extension and held by the breech lock against the rear of the cartridge in the chamber. As the bullet travels out of the barrel, the force of recoil pushes the recoiling parts (the barrel, barrel extension, and bolt) rearward. This causes the bolt to withdraw the empty cartridge from the chamber and the extractor to draw a live cartridge from the belt. It also unlocks the belt from the barrel extension and begins the action necessary to cock the gun for the next round.

As the recoiling parts continue to move rearward, the barrel extension strikes the accelerator, totaling it to the rear; which speeds up both the separation of the bolt from the barrel and the bolt's rearward movement, and also compresses the buffer springs of the barrel. After the barrel and barrel extension travel 1.125 inches rearward, their recoil movement is stopped completely by the barrel buffer (an air buffer). The bolt continues to travel rearward until it strikes the buffer plate in the backplate assembly; during this travel the driving springs and the Belleville springs are compressed.

When recoil is completed, these compressed springs force the belt forward, beginning the counterrecoil movement. The bolt strikes the accelerator, rotating it forward. This action, plus the accompanying release of the buffer spring, forces the barrel and the barrel extension forward. As counterrecoil continues, the bolt is locked to the barrel extension, and the next round is chambered. This action causes the empty cartridge case to be ejected.

SECTION IV.

CALIBRE .50 T164 SERIES MACHINE GUN (REVOLVER TYPE)

SPRINGFIELD ARMORY

German MG-213 Automatic Gun

History

Springfield Armory investigated the possibility of using a revolver-type mechanism essentially a German MG-213 automatic gun. In June 1951, a group of consultants, appointed to give advice and propose possible approaches to the development of a new calibre .50 tank machine gun, recommended that a revolver-type machine gun be developed as an interim weapon. In their opinion, such a gun could be developed more quickly than guns with other mechanisms. However, they also believed that a revolver mechanism was not best for a tank machine gun so they suggested that other approaches be made as well.

The gun developed in accordance with these recommendations was designated the T164 in August 1951. Basically, it was a calibre .50 version of the T130 calibre .60 and the M39 20mm automatic guns, modified to fire percussion-primed ammunition. It was a revolver-type, automatic, air-cooled, gas-operated gun that weighed about 90 pounds and was 53.5 inches long. Its distinguishing feature was a revolving drum containing six cartridge chambers parallel to its axis of rotation. This drum was mounted on a shaft within the drum support, so that, as each chamber reached the 6 o'clock firing position, it was brought into alignment with the barrel. The gun fired standard calibre .50 ammunition belt-fed from either side of the weapon.

While the results of developmental tests at Springfield Armory in 1952 were encouraging, the T164 gun was found to exceed the cross-section limits prescribed by the Ordnance Corps; cook-off and gas leakage problem occurred to an intolerable degree. Accordingly, the gun was redesigned and brought within the prescribed cross-section limits by reducing the size of the drum. The new drum contained five chambers instead of the six. Efforts were also made to eliminate cook-off and gas leakage and further, the drum shaft was eliminated, a manual charger was added, and T94 belt links were fabricated for the gun. This model was designated the T164E1 in August 1952.

The development of the T164E1 continued until January 1955 when a conference was held to discuss the program. The conference members concluded that development should continue only with the designs which could meet the requirements which had been established in 1950. Since there was gas contamination and cook-off problems associated with the T164 design, the conference recommended termination of its development. Therefore, in July 1955, the T164 program was stopped.

Description and Purpose

The T164 Calibre 50 Machine Gun is a smaller calibre version of the Calibre .60 T130 and 20mm M39 revolver type machine guns. One difference is that the T164 fires percussion primed ammunition while the other two fire electrically primed ammunition.

The T164 weapons were gas operated single barrel revolver guns with five and six chamber drums. The ammunition was held in disintegrating metallic links and could be fed from either side by a sprocket type feeder. The last version of the Series, the T164E1 was 53.5 inches long, weighed 89 pounds and had two rates of fire, 450 rpm and 1,150 rpm.

The T164 was designed to meet the requirements for a replacement for the Calibre .50 M2-HB machine gun for use in armored vehicles.

Cycle of Operation

Basically, the T164 operates the same as the M39 20mm automatic gun. When the gun is fired, some of the propellant gases are forced through a port in the barrel to actuate a piston which drives the operating slide rearwards. As the slide moves, the drum rotates by the interaction of rollers located on the periphery of the drum and in the path of the operating slide cam.

The drum-driven feed mechanism is a multiple sprocket which pulls in the linked rounds. Cartridges are pushed from the link belt and into a drum chamber by a two-stage rammer attached to the operating slide. When a round is fired, the operating slide is driven rearwards, and the drum's indexing mechanism positions an empty chamber in the path of the upper ramming face. As the slide returns to its battery position, the upper face of the rammer pushes a cartridge from its link and partially sears it in the drum chamber. When the next round is fired, the drum indexes again and rotates the partially chambered round into the path of the lower face of the rammer, which drives it into the chamber; at the same time, the rammer's upper face pushes another cartridge from its link. A spring-loaded, retainer, which snaps upward and pushes against the base of the completely chambered round, holds the cartridge in position until it is fired. When the drum indexes again, the fully chambered round moves to the six o'clock battery position, where it is in alignment with the barrel and the firing pin. A striker attached to the operating slide causes the extractor to remove an empty cartridge case after firing; as the slide comes into battery position, cam action causes the striker to rotate the extractor, thus pulling the case from the chamber.

SECTION V.

CALIBRE .50 T176 SERIES MACHINE GUN

U.S. ARMY ORDNANCE CORPS

History

The development of the T176 was begun in January 1952. A prototype was made, and after firing about 5,000 rounds, contracts were let for the fabrication of eight additional guns. Three of these included all the improvements and modifications resulting from the firings of the prototype; the other five guns were to be made after test firings of the first three had been completed, and were to include all the modifications that the tests indicated to be desirable.

Since engineering tests of the T176 indicated a number of deficiencies, the gun was modified to eliminate them. The new model, which was designated the T176E1 in March 1955, had a smaller receiver than the previous version, and therefore, it was shorter overall. The accelerator was reduced in size and relocated, and the rate changing device was redesigned.

The development of the T176E1 continued until January 1955 when a conference was held to discuss the program. Since there was insufficient time and money available to continue to investigate a number of different approaches to the goals of the program, the conference members concluded that development should continue only with the designs which could meet the requirements which had been established in 1950. Since the T175E1 was further developed than the T176E1, all work on the latter weapon was terminated in July 1956.

Description and Purpose

The T176 is an air-cooled, recoil-operated, disintegrating metallic link belt-fed calibre .50 machine gun. It weighs about 59 pounds and is 60 inches long. The barrel weighs 21.2 pounds and is 45 inches long. The gun fires standard calibre .50 ammunition. The ammunition belt can be fed from either side. The loading system used is a rotating bolt.

The last version of the series, the T176E1, was 54.9 inches long, weighed 85.75 pounds. The barrel was 40 inches long and weighed 17.9 pounds. The gun had two rates of fire. The gun was charged manually by pulling an external handle to the rear. This operated the bolt lock, retracted the firing pin, and moved the bolt to the rear. The barrel was not moved and the accelerating springs were not compressed, so the manual effort necessary to charge the gun was greatly reduced. The gun was triggered by an internal solenoid.

The purpose of this gun was to fulfill the need for a short receiver, dual rate of fire tank machine gun to replace the calibre .50 M2HB.

Cycle of Operation

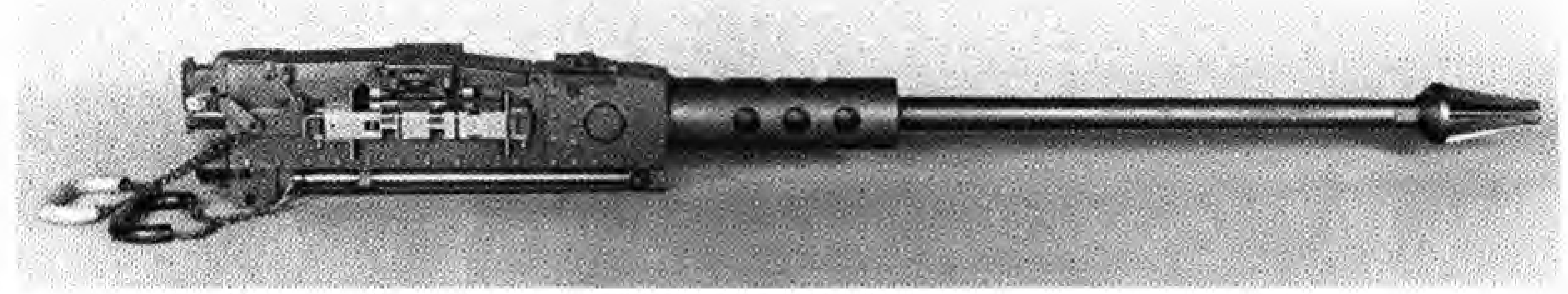
When a round is fired, the recoiling group, the barrel, barrel extension, and bolt move rearward together until the bolt could be unlocked safely. The barrel travels to the rear about 0.25 inch before unlocking begins during which time the firing pin is retracted and the firing pin spring is compressed. During the next 0.375 inch of rearward travel, the bolt is unlocked by the action of a cam in the receiver. This cam action also begins the extraction of the empty cartridge. The recoil of the barrel compresses a pair of springs that are released when the bolt is unlocked and accelerate its movement to the rear. In the end of the recoil movement, the barrel strikes a buffer plate, and the buffer springs return the barrel to the battery position.

The feed mechanism of the T176 is actuated by the movement of the barrel, half of the feeding operation being accomplished during recoil and half during counterrecoil. The gun can be fed from either side by repositioning some of its parts. A side-stripping link is used, and, as the bolt recoils, a round is stripped from its link and forced down into the feed trough. The bolt is stopped by a spring-and-buffer combination at its extreme recoil position and is latched there if the trigger is released. If the trigger is held down, the bolt is returned in counterrecoil by the return spring, picking up the round from the trough and ramming it into the chamber. The rotary bolt locks are actuated by cam action to lock the bolt to the barrel, and the firing pin cannot operate until the locks have turned to a safe position. Locking movement beyond this safe position releases the firing pin. The dual rate of fire is accomplished by an external lever that varies the compression of the accelerating springs.

SECTION VI.

CALIBRE .50 T175 SERIES M85 MACHINE GUN

AIRCRAFT ARMAMENT, INC.



Calibre .50 M85 Machine Gun (fixed—left rear view)

History

In January 1956, work was concentrated on the T175 program and development of the other three guns was ceased.

The T175, which Aircraft Armaments, Inc. began working on in January 1952 under contract with Springfield Armory, was short recoil operated with a hydraulic accelerator. The accelerator caused considerable difficulty, particularly in cold weather. Therefore, in November 1955, the T175E1 was designed, which incorporated a mechanical accelerator in lieu of the T175's hydraulic accelerator.

Description

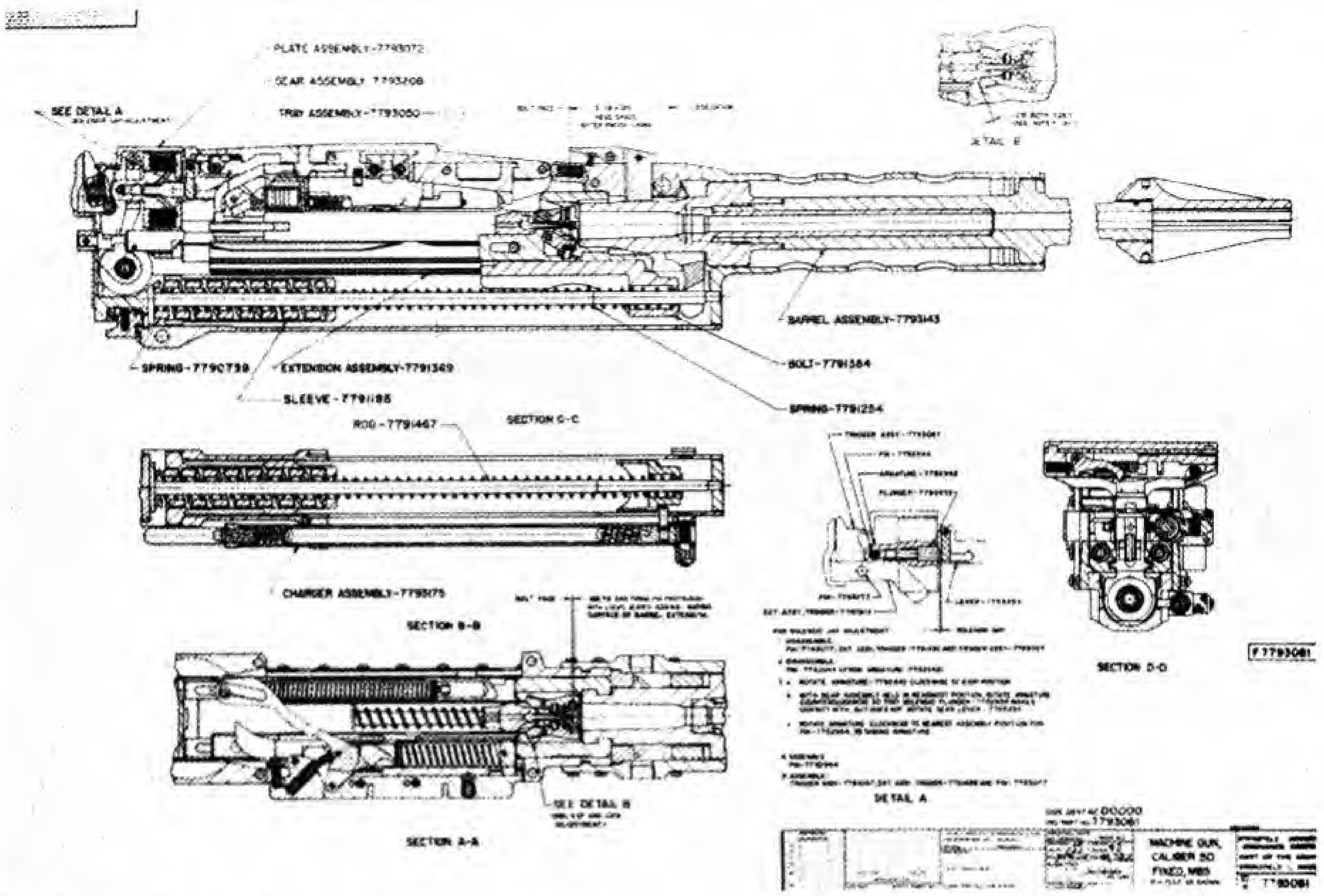
The T175E1 was a recoil-operated, air-cooled, calibre .50 machine gun with a dual rate of fire, 400 rounds per minute at low rate and 1,050 rounds per minute at high rate. The ammunition, held by push-through, disintegrating, metallic belt links, designed especially for the T175E1, could be fed from either side of the weapon. The energy of the recoiling barrel operated the feeding mechanism. The gun could be fired either electrically or manually, although manual firing was for emergency use only. Experienced personnel could field strip the gun in 15 seconds and reassemble it in 25 seconds. The barrel, which was 36 inches long without a flash suppressor, could be changed in 5 seconds.

Including its flash suppressor, the T175E1 machine gun weighed 57.35 pounds and was 54.5 inches long. Without a link chute, it was 4.408 inches wide, and its maximum height, with the cover closed, was 6.075 inches. The receiver was 18.5 inches long, as compared with the 26-inch receiver of the M2.

Two symmetrical wing locks locked the bolt to the barrel extension during firing. These locks were mounted on the bolt block and were actuated by the bolt slide. When rigidly mounted and fired in twenty-round bursts, this weapon had a dispersion of three mils or less. No special lubricants were needed for the weapon, and no adjustments were required in the field.

Three T175E1 guns were given engineering tests at Aberdeen Proving Ground between January and May 1958. A number of stoppages occurred because the firing pin struck the primer lightly. This was the result of thermal expansion of the barrel, which caused the barrel to bind in the barrel bearings, so that the gun functioned sluggishly. In addition, the feed-and-ejection assembly did not operate satisfactorily. Aberdeen Proving Ground recommended that the development of the T175E1 be continued in an effort to improve its reliability and durability and requested that the improved model be submitted for additional engineering tests.

The tests first showed that the T175E1 had a number of advantages over the M2-HB machine gun. The overall length of the T175E1 was 10.9 inches less than that of the M2, with most of this reduction in its receiver (8.4 inches). This short length is an advantage for a weapon to be mounted in a tank cupola. The T175E1 was 20.9 pounds lighter than the M2. The T175E1 fired from the open-bolt position, and the barrel had fixed headspace. Finally,


SEE DETAIL A
PLATE ASSEMBLY-7793072
SEAR ASSEMBLY 7793208
TRAY ASSEMBLY-7793050
DETAIL E
BARREL ASSEMBLY-7793143
BOLT-7791584
SPRING-7791254
SPRING-7790739
EXTENSION ASSEMBLY-7791369
SLEEVE-7791188
ROD-7791467
SECTION C-C
CHARGER ASSEMBLY-7793175
SECTION B-B
SEE DETAIL B
SECTION A-A
DETAIL A
SECTION D-D
F7793081
MACHINE GUN, CALIBER .50 FIXED, M85

M85 Major Groups and Components (Exploded View)

the high cyclic rate of fire of the T175E1 was from 60 to 100 percent more than that of the M2, a significant advantage for a weapon that was to be fired at low-flying aircraft.

Some disadvantages of the T175E1 were disclosed during the tests. When fired at the low rate, the gun was generally less reliable than when fired at the high rate. The rate-reducing mechanism increased the cost of the weapon. The feeding mechanism of the T175E1 was not as reliable as that of an M2-HB machine gun. Stoppages during the tests could not be cleared as easily or as quickly as in an M2. Other unsatisfactory features of a minor nature were remedied by redesign or by greater precision in fabrication.

In order to hasten the development of the weapon, the work was divided into two parts. First, two guns were modified for additional engineering tests at Aberdeen Proving Ground in August 1958. Then six guns were fabricated for service tests, four to the U.S. Army Armor Board and the other two to the Arctic Test Board. All of these guns had improved parts.

During the service tests, which began in November 1958, the gun performed satisfactorily, although some parts were not sufficiently durable.

However, major deficiencies were found in the belt links which had been developed for the T175. Some cartridges began to move out of their links before reaching the feedway, and sometimes the connecting loop of the link dropped into the feedway when the ammunition was fed from the right-hand side of the gun. Since it was believed that these deficiencies were inherent in the design of the series of belt links, it was decided to develop a calibre .50 version of the 7.62mm metallic-belt cartridge link, which had been adopted as standard for the M60 7.62mm machine gun in February 1957. The new link was designated the XM15 in February 1959.

Because the new link could not be used in the feeding mechanism of the T175E1 gun, work was begun on the T175E2, with a feeding mechanism for the XM15 link. Otherwise, the new model was identical with the T175E1, except for those parts that had been made more durable.

Because the service tests of the T175E1 gun had shown that it was satisfactory for use on tanks and because the redesign of the feeding mechanism would not change the outer dimensions of the receiver or of the gun, it was recommended the T175E2 and the XM15 link be adopted as standard items. This would make available a standard calibre .50 machine gun for the new tank, which was adopted as standard A in April 1959. So, in June 1959, the gun and the link were classified standard A as the M85 calibre .50 tank machine gun and the M15 metallic-belt cartridge link.

Since its adoption in 1959 the M85 has undergone continued testing and product improvement. The initial production was done by Springfield Armory. Between 1968 and 1970 General Electric produced 2,098 guns and by 1972 M85 machine guns produced at Rock Island were approved for release. The guns produced by Rock Island demonstrated a significant improvement in the malfunction rate over earlier production. The Rock Island produced guns had a malfunction rate of 0.25 per thousand rounds while the earlier rate was 1.01 per thousand rounds.

The changes that have been made in the M85 since 1959 have been relatively minor and some are related to the mount such as the redesign of the charger handle to avoid interference in the M19 cupola. Problems have included: short life of the firing pin, the riveted receiver and cover assemblies are complicated and expensive, and there has been cracking of the locking lugs. In 1974, a product improvement program attacking those problems was reported by Watervliet Arsenal. TRW, Inc. also began working on developing a powder metalurgical method for production of certain complex components of the M85.

Characteristics

Weight	65 lbs.
Weight of Barrel with Flash Suppressor	16.25 lbs.
Length	54.5 in.
Length of Barrel with Flash Suppressor	40 in.
Height	5.9 in.
Width	5.25 in.
Rifling:	
Length	32.6 in.
No. of Grooves	8
Twist, Right-Hand	One turn in 15 in.
Rate of Fire (cyclic):	
High	800-950 spm
Low	400-500 spm
Feed	Disintegrating metallic link belt
Operation	Recoil
Cooling	Air
Muzzle Velocity	2840 to 3450 fps

A user survey done in 1968 under the auspices of the U.S. Army Weapons Command showed that over twenty percent of the users surveyed particularly liked the fixed headspace, quick change barrel, and selective rates of fire. Those three features are improvements over the older M2-HB. The survey also pointed out some problems, some of which were due to lack of experience (the average experience was only 7.9 months), and some of which were due to design deficiencies. Recommendations to eliminate the latter were made to the appropriate authorities. Over 90 percent of the queried users regarded the M85 as a dependable weapon.

Presently, there are two versions of this weapon, the M85 which is for coaxial mounting in armored vehicles and the M85C which is the flexible version. The difference between the two versions is that sights and a spade grip assembly are mounted on the M85C.

The firing cycle is triggered from the open bolt position. A disintegrating metallic link-belt is utilized. The feed direction of the weapon can be changed by repositioning a limited number of components. Design features include fixed headspace, quick change barrel with flash suppressor, dual rate of fire, and electrical (by solenoid, 24 volt DC) or manual operation.

Cycle of Operation

Triggered from the open bolt (seared) position, the bolt assembly receives energy from the driving spring to strip, chamber, lock and fire the first cartridge. Recoil energy is supplied by the recoiling barrel's reaction to the fired cartridge. Momentum of the recoiling barrel, integrally locked with the barrel extension and bolt assembly actuates the feed mechanism, and unlocks the bolt assembly accelerating it rearward. As the bolt assembly moves rearward it extracts and ejects the empty cartridge case. The rearward travel of the bolt assembly is arrested when the bolt slide contacts the buffer sleeve. Counterrecoil force is supplied by the energy stored in the drive and buffer springs compressed during the recoil movement.

High Rate of Fire Sequence-Recoil. Upon firing, the barrel, barrel extension and locked bolt assembly, integrally engaged, start the recoil stroke as a unit.

The actuator feed assembly and bolt slide are actuated simultaneously by the recoiling barrel extension and barrel respectively.

Actuation of Feed Mechanism. The recoiling barrel extension acts upon the actuator feed assembly, positioned behind and against the head of the extension, carrying it rearward. During its travel the actuator feed assembly is guided and retained (laterally) by a slot in the support of the feed and ejector assembly.

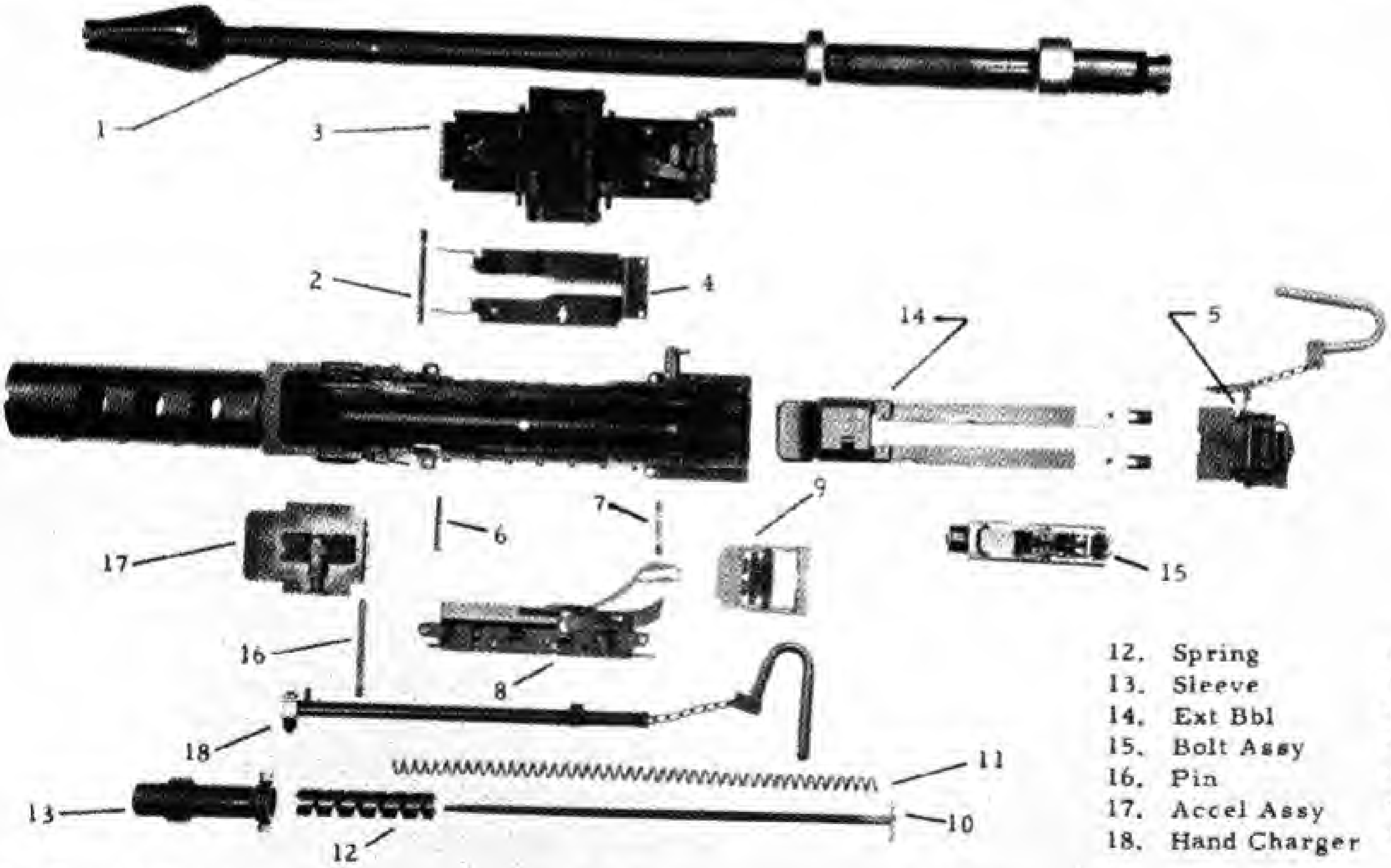
A spring loaded plunger, contained within the actuator feed assembly to dampen the shock of recoil, contacts and imparts angular motion to a pivoting feed actuator lever. The lever is cammed out of the path of the bolt assembly during recoil.

An elongated camming slot in the feed actuator lever drives a pivoting feed lever contained in the cover assembly. Motion is then transferred transversely to the spring loaded feed slide assembly, connected to the feed lever, causing it to move in an inboard direction.

Prior to the movement of the feed slide assembly, the feed pawl on the slide engages the link of the cartridge to be fired. As the slide moves inward against spring pressure, a ramp surface on the slide pivots the spring loaded cartridge stop pawl of the feed return housing assembly contained in the cover, down into position, stopping the cartridge centrally on the feed tray.

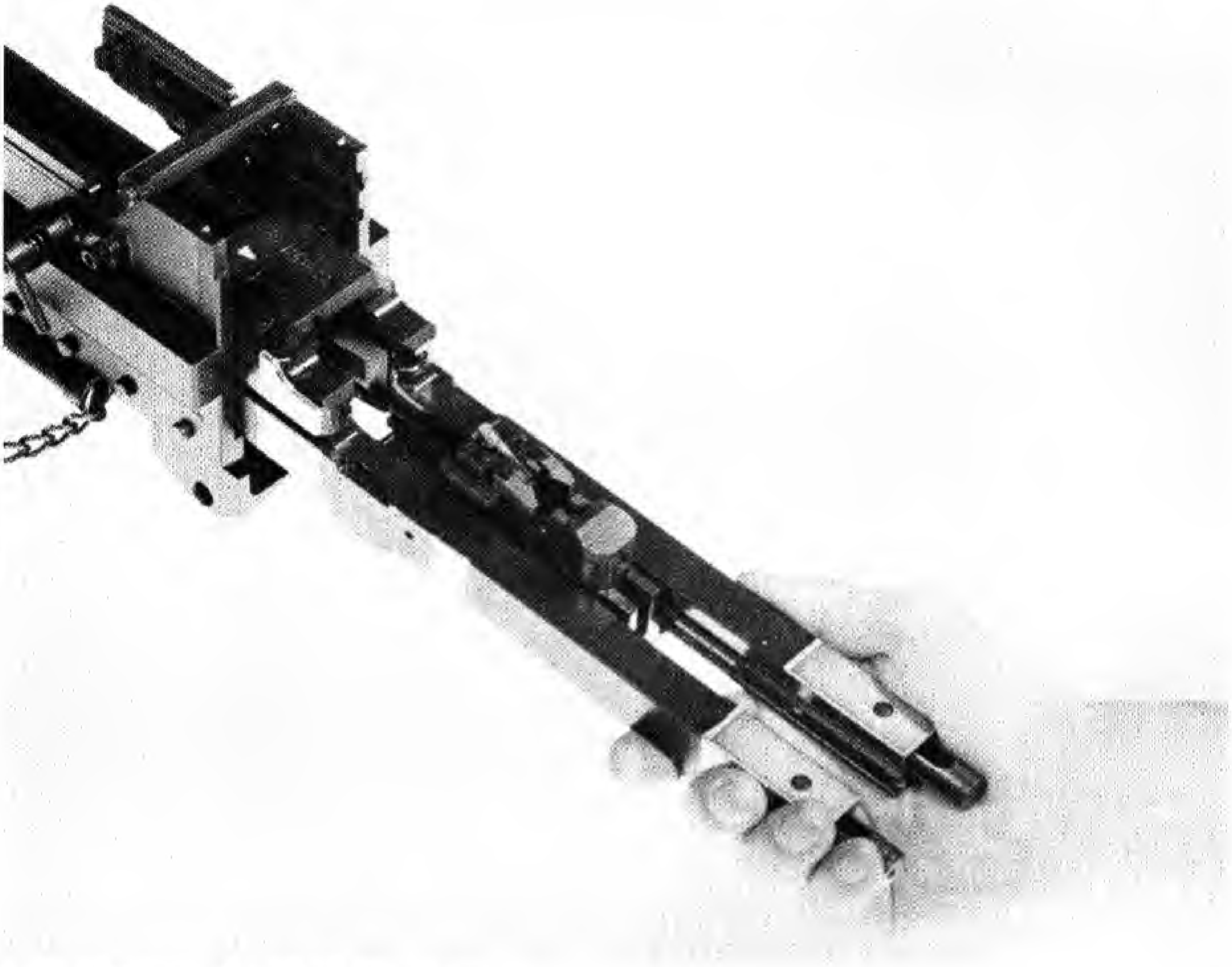
As the cartridge contacts the cartridge stop pawl, two belt holding pawls depressed by the succeeding cartridge, spring up behind the cartridge and hold the ammunition belt in position.

During the feed stroke, a delay action is introduced to stabilize the ammunition belt and maintain the round in proper stripping position. The time elapsed allows the bolt to counterrecoil and assume the proper stripping relationship with the round.



1.	Barrel Assy	7793164
2.	Pin	7793046
3.	Cover Assy	7793227
4.	Feed Tray Assy	7793050
5.	Back Plate Assy	7793072
6. & 7.	Pin	7793045
8.	Feed & Ejector Assy	7793095
9.	Sear Assy	7793208
10.	Rod Guide	7791467
11.	Spring	7791254
12.	Spring	7791739
13.	Sleeve	7791185
14.	Ext Bbl	7791369
15.	Bolt Assy	7791384
16.	Pin	7793044
17.	Accel Assy	7790980
18.	Hand Charger	7793175

Calibre .50 M85 Machine Gun (Field Stripped)



Removal of Extension Barrel and Bolt Assembly

The delay action is accomplished as follows:

During recoil, a cam pocket in the barrel extension together with a slot in the plunger feed housing, align with a "tee" shaped retainer contained in the feed and ejector assembly.

The feed assembly retainer, bearing against the side of the barrel extension under spring pressure, moves into the cam pocket in the barrel extension and engages the slot in the actuator feed assembly, locking the housing to the support (body) of the feed and ejector assembly.

The interlocking action caused by the retainer, occurs at the end of the angular stroke of the feed actuator lever. The lever is subsequently maintained in the feed position until the bolt counterrecoils and begins to strip the cartridge from the link.

Actuation of Bolt Assembly. Upon recoil the shoulder of the rear barrel bearing, contacting the accelerator, pivots the accelerator causing it to strike and actuate the bolt slide.

Rearward movement of the bolt slide accomplishes unlocking of the bolt locks and extraction of the empty cartridge case.

During extraction, the bolt block in its recoil travel maintains control of the empty cartridge case by engagement of the case retainers and extractor in the extractor groove of the case. As the bolt block passes under the feed tray, the spring loaded rammer contained in the bolt block contact underrides the succeeding cartridge positioned on the feed tray.

Just prior to ejection, two angular cam surfaces, located midway in the barrel extension, disengage the extractor from the groove of the cartridge case.

The ejector is a spring loaded and pivoting lever with its rear hook shape positioned in the path of the recoiling bolt assembly. As the rear radial surface of the bolt slide strikes the ejector hook, imparting an outward rotation, the ejector pivots causing the front end to deflect inward and strike the spent cartridge case. Upon contact, the spent cartridge case is disengaged from the case retainer in the bolt block, nearest the ejector. The cartridge case pivots on the opposite case retainer as the ejector sweeps the spent case from the bolt block. Ejection of the case is accomplished through the ejection port opening in the side of the receiver. Simultaneous with the ejection of the spent cartridge case, the link from the previously fired round is pushed out of the feed tray assembly opening by the force of the incoming cartridge being fed.

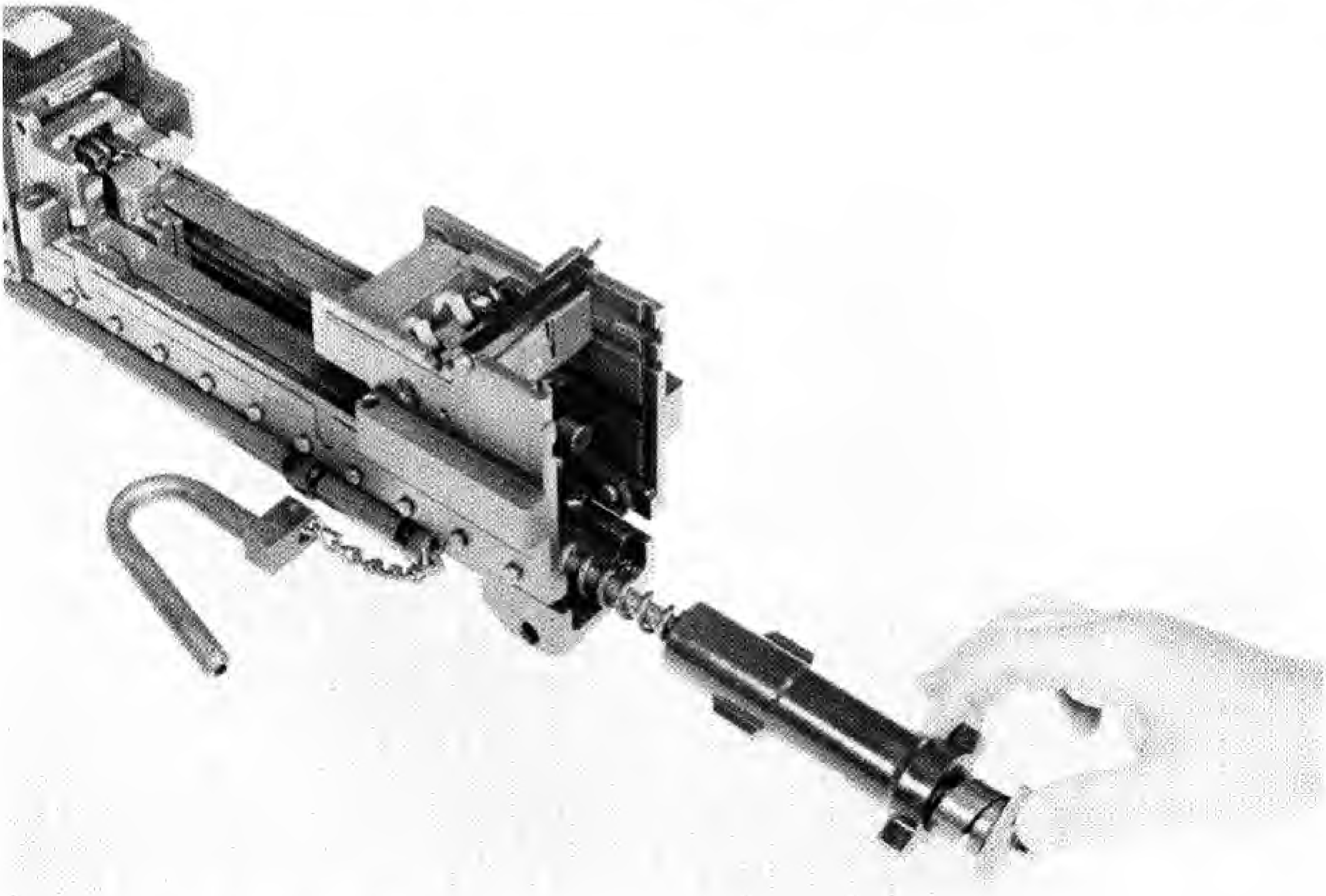
The remaining recoil force of the bolt assembly is absorbed by the buffer spring at the end of the recoil stroke.

High Rate of Fire Sequence-Counterrecoil. Forward motion of the bolt assembly is initiated by the energy stored in the buffer and drive springs compressed during the recoil stroke.

As the bolt assembly travels forward, the spring loaded rammer contained in the bolt block contacts the base of the cartridge and proceeds to strip it from the link. The link is retained longitudinally by engagement with the spring loaded link stripper contained in the cover.

Unlocking of the actuator feed assembly from the support, of the feed and ejector assembly, occurs simultaneously with the beginning of the stripping operation. The retainer is cammed out of the slot in the housing by the counterrecoil movement of the barrel extension. Counterrecoil force is supplied by the (two) barrel return rod springs, contained in the barrel extension, compressed during the recoil stroke.

As the unlocking action takes place, the feed slide return springs, compressed during the feed stroke, return the feed slide assembly to the pre-feed position



Removal of Buffer Group Assembly

completing the feed cycle. During this movement the feed pawl overrides and engages the next round.

As the bolt slide strips the cartridge from the link, the projectile of the cartridge contacts the cartridge guide ramp of the cover assembly. The cartridge, driven forward by the bolt slide, is cammed downward in a canted position causing the base end of the cartridge to slide down the face of the bolt as the nose of the projectile enters the chamber of the barrel. The base of the cartridge comes to rest on the lips of the bolt slide as the extractor groove is engaged by the case retainers and extractor. NOTE: In the event that the cartridge is not engaged by the case retainers or extractor during the normal camming operation, these spring loaded components cam around the rim of the cartridge case upon chambering of the cartridge.

During chambering of the cartridge the bolt block enters the lock area of the barrel extension and stops against a transverse surface of the extension controlling headspace.

As the bolt block stops against the barrel extension, the bolt slide continues its forward travel allowed by the elongated slot of the breechblock, during which locking of the bolt block takes place. The bolt locks are cammed outward into the locking recesses of the barrel extension by the cam surfaces on the bolt slide. After locking is accomplished, the bolt slide, transports the firing pin through the firing pin hole in the bolt block, strikes and ignites the primer of the cartridge. The protrusion of the firing pin beyond the cartridge seat of the bolt block is controlled as the bolt slide is stopped by a transverse surface located at the front end of the barrel extension.

Upon firing the chamber pressure is exerted, through the bolt block and bolt locks, against the lock surfaces of the barrel extension.

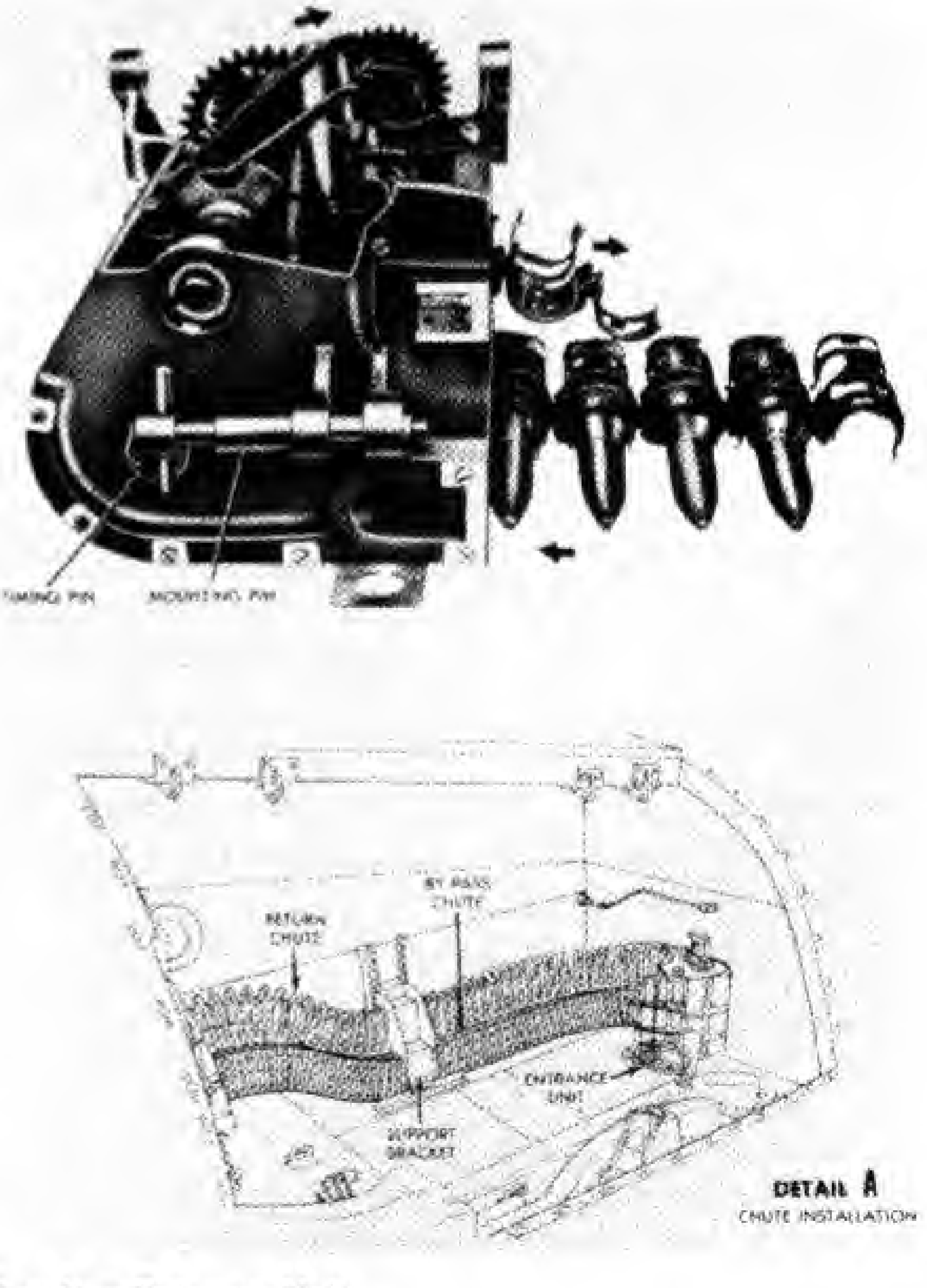
Low Rate of Fire Sequence-Recoil. The cycle is the same as described for the high rate of fire sequence except that at the end of the recoil stroke, the low rate (delay) mechanism is actuated as follows:

When the rate selector, located at the back of the end plate, is positioned on "L" (low rate of fire) the projecting lug of the striker assumes the six o'clock position and interrupts the path of the recoiling bolt slide. (At high rate setting, the lug assumes the twelve o'clock position and remains out of the path of the bolt slide). Tangs at the rear of the bolt slide impact the spring loaded striker driving it rearward against the lug on the cylinder.

Prior to its actuation, the radial position of the cylinder is qualified by a stop surface on the end plate. A pre-loaded (1/2 turn) torsion spring houses within the cylinder and attached to the cylinder shaft maintains bearing between the stop surfaces of the cylinder and end plate.

The disconnector, hinged on a quick release pin at the top of the end plate, is positioned forward of a transverse (self retaining type) pin assembled through a hole in the rear of the solenoid armature. A clearance hole in the center of the disconnector accepts the shank of the armature. The disconnector has two legs. The bottom of each leg is equipped with a roller that rests freely against an angular surface on the cylinder.

The impact force transmitted by the striker causes the cylinder to rotate and pivot the disconnector. The cylinder rotates against increasing resistance of the torsion spring, storing energy in the spring for the counter-rotation movement of the cylinder. The disconnector pivots during the initial rotation of the cylinder as the rollers on the disconnector are



Loading Entrance Unit

cammed from the rest position to the periphery of the cylinder.

As the disconnector pivots, the rear surface contacts the transverse pin in the armature, retracting the energized solenoid plunger from contact with the sear lever. This action causes the spring loaded sear to return to the searing or engaging position for the breechbolt.

The bolt slide in its counterrecoil stroke is engaged by the sear until a delaying action caused by the cylinder is completed. After the disconnector pivots, the cylinder continues its rotation through a total of 210° until an angular stop surface on the cylinder contacts the stop surface of the end plate. Counter-rotation is effected by the increased torsional force exerted by the cylinder spring. As the cylinder nears the end of its counter-rotation, the rollers on the disconnector are returned to the original rest position on the cylinder by the force of the energized solenoid. The energized solenoid plunger returns to the forward position and actuates the near mechanism releasing the bolt slide.

Low Rate of Fire Sequence-Counterrecoil. The counterrecoil is the same as the high rate of fire sequence except the bolt slide is seared by the action of the low rate mechanism. The counterrecoil force exerted by the buffer and drive springs is absorbed by buffing units contained in the sear block and attached to the sear. Upon release the bolt slide obtains its counterrecoil force, necessary to strip and chamber the next cartridge, from the remaining energy contained in the drive spring.

SECTION VII.

CALIBRE .50 GENERAL PURPOSE HEAVY MACHINE GUN AND LIGHTWEIGHT GENERAL PURPOSE MACHINE GUN

AIRCRAFT ARMAMENT, INC.

History

In September 1982, the AAI Corporation manufactured and tested the Calibre .50 General Purpose Heavy Machine Gun. This new General Purpose Heavy Machine Gun is a gas operated, dual feed, lightweight, calibre .50 machine gun, designed to replace the current M2HB and M85 machine guns.

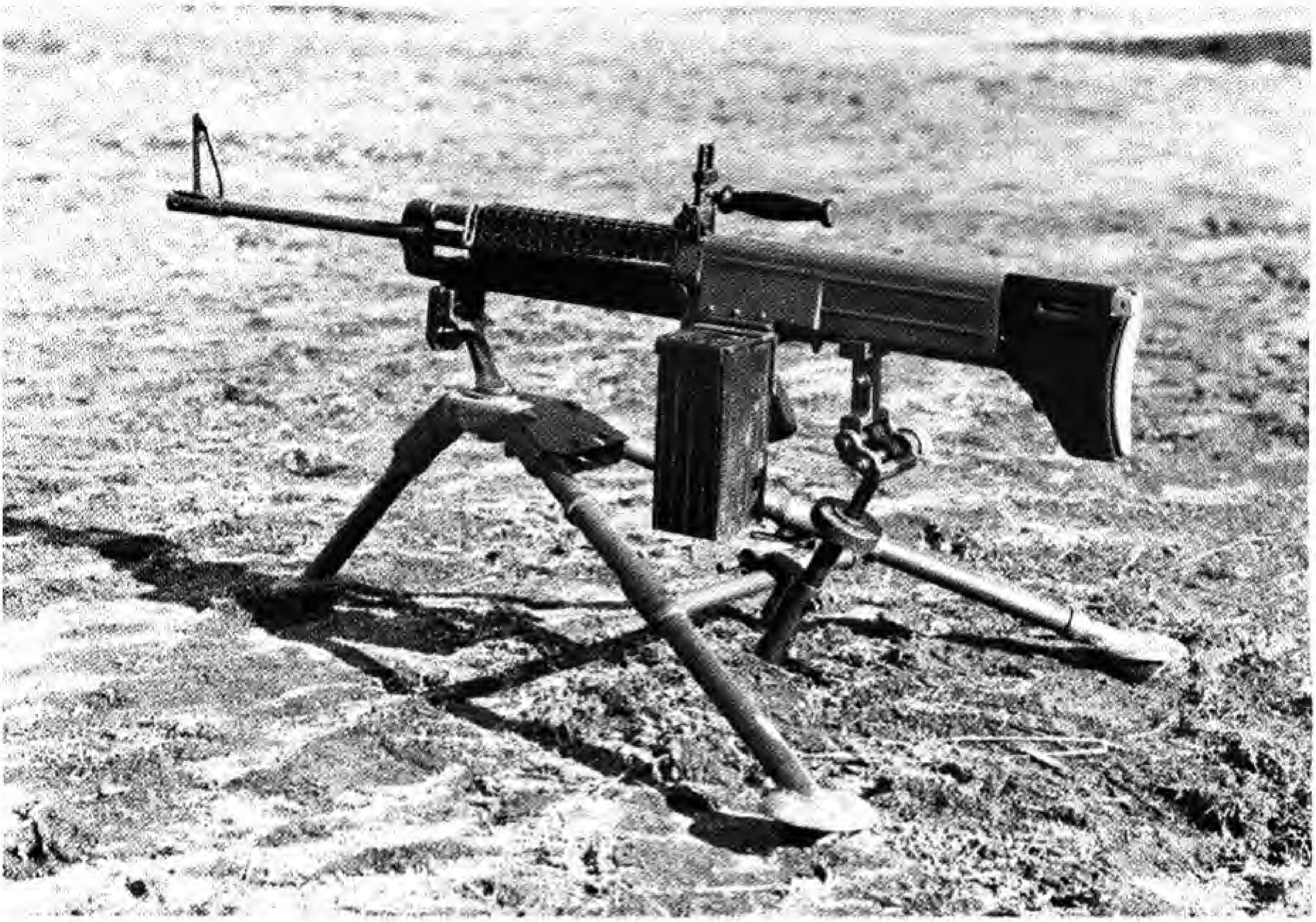
Three prototype weapons were manufactured and base line tested under the direction of the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), under contract to the AAI Corporation, Baltimore, Maryland.

The calibre .50 machine gun, developed under this contract, was designed to replace the current M2HB and M85 machine guns on surface vehicles, aircraft, ships and ground mounts. It has 30% fewer parts and is less costly to produce than existing calibre .50 guns. A principle advantage of the weapon is the ability to instantly select from ball ammunition on one belt to special purpose ammunition on the other belt. Two belts of the same type ammunition could be used to give a substantial increase in the volume of fire before reloading. Additional features are a quick change barrel with fixed head space and timing.

Description

The Calibre .50 General Purpose Heavy Machine Gun (GPHMG) is a dual feed, belt fed, gas operated, air cooled, fully automatic weapon with a quick change barrel and fixed head space and timing. It has a firing rate of 400 rpm. The weapon is loaded, fired, unloaded, and cleared in the open-bolt position. This weapon provides the U.S. Forces with a lightweight, dual feed, state-of-the-art Calibre .50 machine gun applicable with Rapid Deployment Force (RDF) applications, as well as vehicular, aircraft, marine, and ground mount applications.

The GPHMG can be fired from the M3 ground mount, the M36 vehicle mount, the M63 anti-aircraft mount, or the M122 tripod mount.



Calibre .50 General Purpose Machine Gun

The Calibre .50 Lightweight General Purpose Machine Gun (LWGPMG), is a fully automatic, air cooled, gas operated, belt-fed calibre .50 inch machine gun which functions from the open bolt position. The weapon features both fixed headspace and timing, incorporates a quick change barrel, and is capable of firing all standard U.S. and NATO calibre .50 inch ammunition, as well as the developmental Saboted Light Armor Piercing Ammunition, at a nominal firing rate of 400 shots per minute.

The weapon features a receiver of tubular design, an integral sprocket driven feed mechanism, dual tappet gas system functioning, and modular subassemblies which provide for immediate operator and unit level maintenance with minimum weapon down time.

Individual components and subassemblies have been designed to withstand normal loading, plus a margin of safety, such that catastrophic failures should not occur under normal operating conditions.

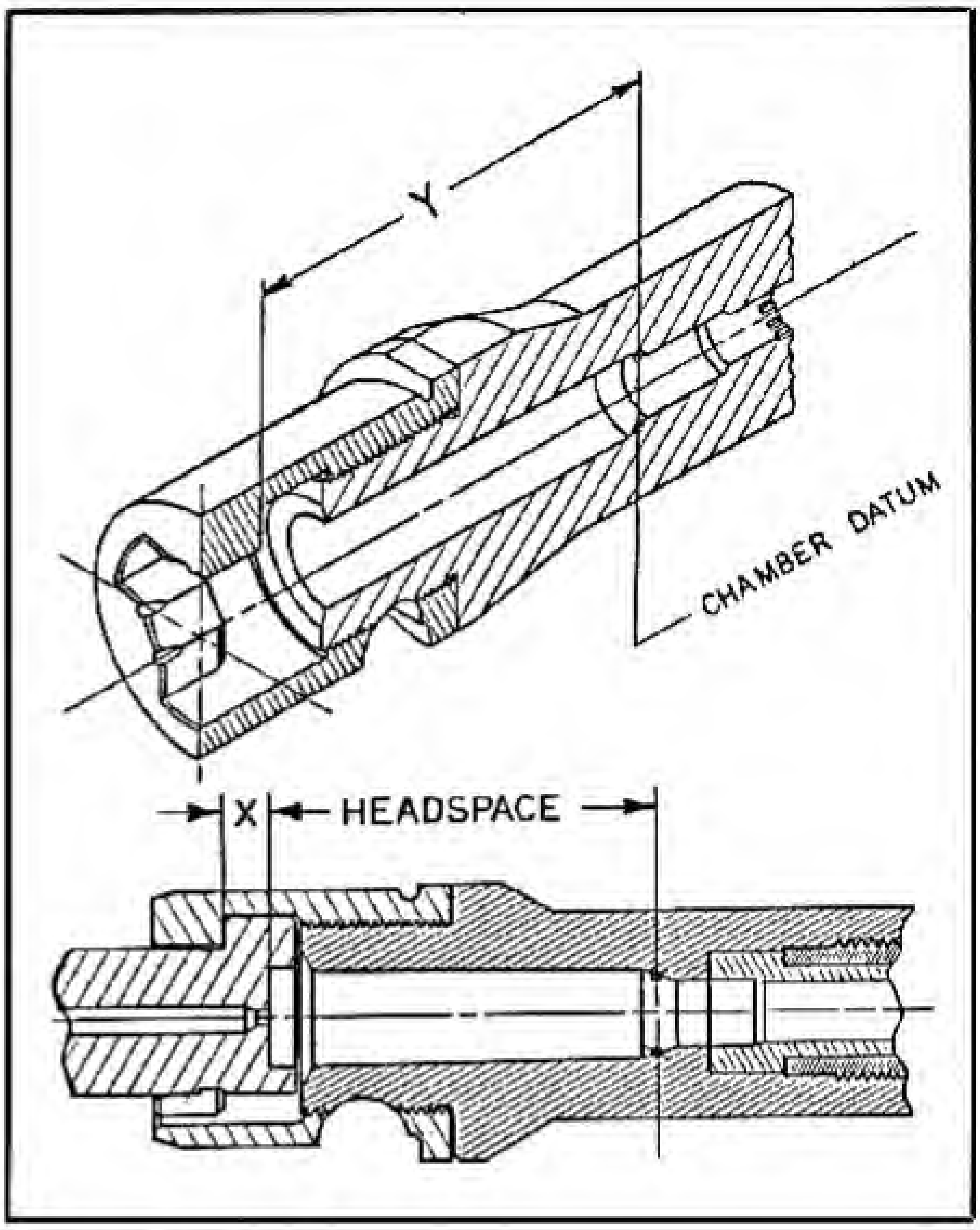
All components are completely interchangeable between individual weapons.

GPHMG Characteristics

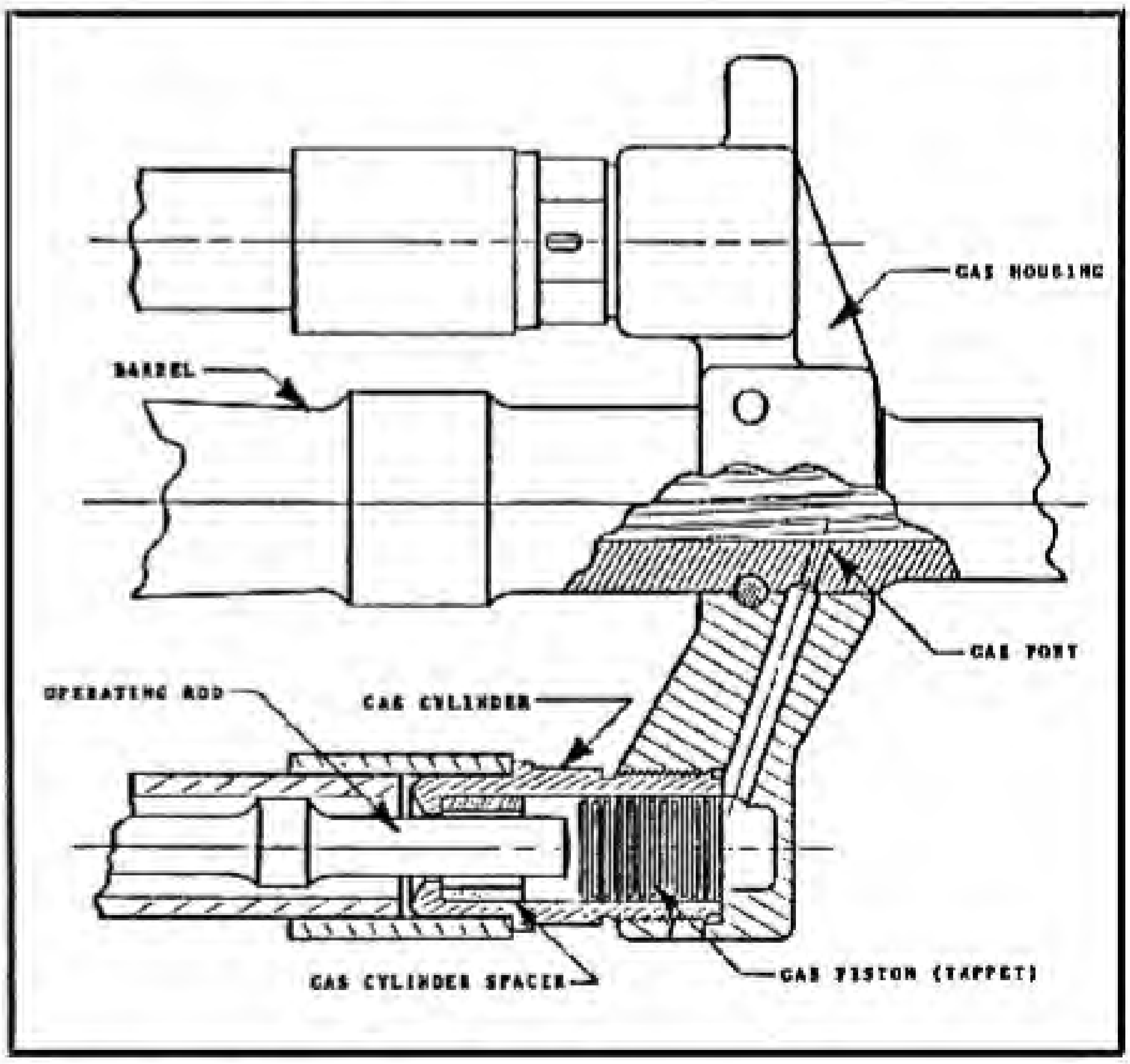
Weight	60 lbs.
Length	61 in.
Firing Mode	Automatic
Rate of Fire	400 rpm
Feed	Dual-Selective
Head Space	Fixed
Timing	Fixed
Effective Range	2,195 meters
Maximum Range	6,700 meters
Operation	Dual Gas Pistons, Fires from the Open Bolt
Ammunition	Belt Fed Low/High Impulse
Number of Parts	190

LWGPMG Characteristics

Weight (complete with light barrel)	47.3 lbs.
Weight of Light Barrel	14.4 lb.
Weight (complete with heavy barrel)	49.9 lb.
Weight of Heavy Barrel	17 lb.
Length of Weapon with barrel	72.4 in.
Length of Receiver without barrel	43.6 in.
Length of Barrel with flash hider	41.6 in.
Length of Rifled Bore (approx.)	32 in.
Number of Lands and Grooves	8
Twist	Right Hand, one turn in 15 in.
Headspace/Barrel Changing	Fixed Headspace/ Quick Change
Timing/Locking	Fixed Timing/ Rotary Locking Bolt
Feeding	Rotating Sprocket, Disintegrating Metal Belt
Operation	Dual Tappet Gas
Firing	Inertia Fired from Open Bolt Position
Cooling	Air
Muzzle Velocity (approx.)	2,900 fps
Cyclic Rate of Fire (nominal)	400 rpm
Ammunition/Link	All NATO Calibre .50 inch and SLAP/M15A2



Weapon Headspace



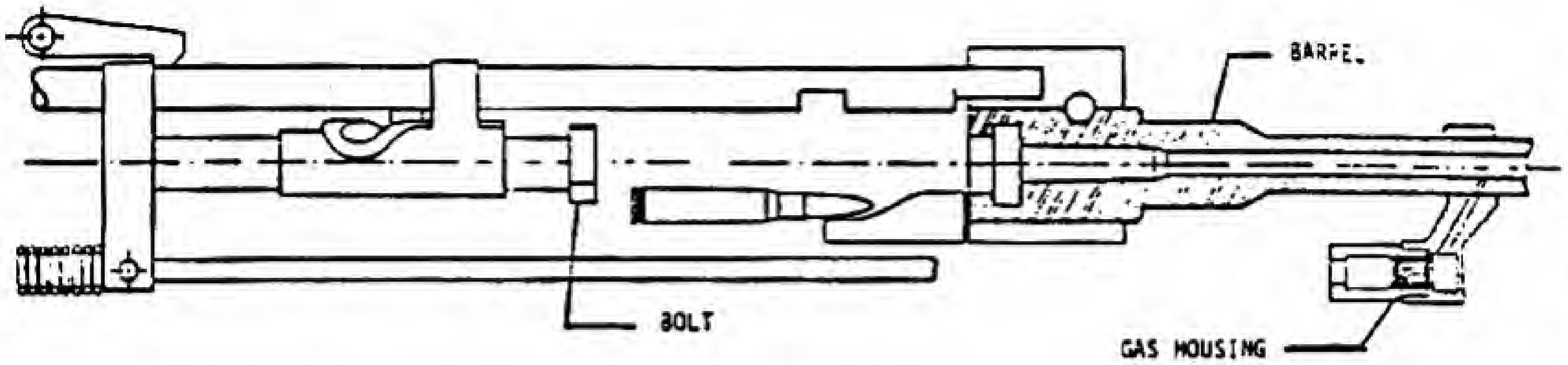
Weapon Gas System

Cycle of Operation

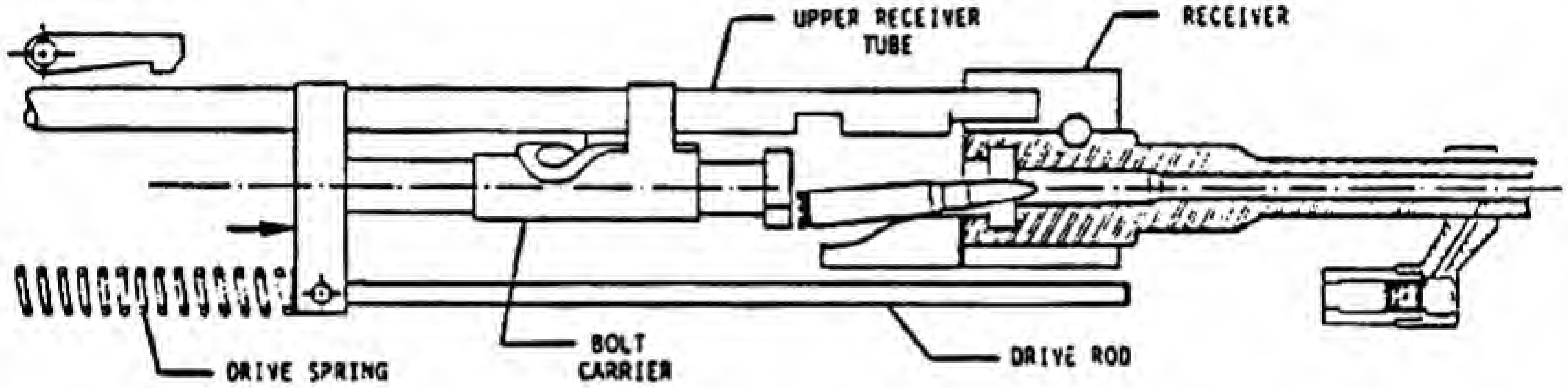
Weapon operation begins with the bolt carrier seared to the rear in the open bolt position. When the sear is released, the bolt carrier assembly begins forward motion, driven by the two drive springs. A live round, held into position by one of the feed sprockets, is then stripped from the feed belt by one of the two bolt rammers and cammed forward into the chamber. As the bolt carrier continues forward, it cams the bolt to the locked position. Round ignition now occurs as the firing pin, attached to the bolt carrier, strikes the primer. The bolt carrier remains at this position until the projectile travels past the two gas ports. Propellant gas will now flow through these two orifices and into each of the gas cylinders. As gas pressure builds, each gas piston is driven rearward against a drive rod connected to the bolt carrier by the drive pin which now begins rearward motion. After 0.10 inch of dwell, the carrier begins to cam open the bolt and after 0.62 inch of rearward motion, the piston stroke ends and the bolt is unlocked. At this point, the carrier has enough kinetic energy to cycle the weapon.

Bolt pickup occurs when the cam pin contacts the end of the carrier cam track. After bolt pickup, the bolt and carrier recoil as an assembly with the bolt held into the unlocked position by the cam pin bearing against the upper receiver tube. As the carrier recoils rearward, both feed cams rotate towards the weapon centerline. One feed sprocket remains stationary as the

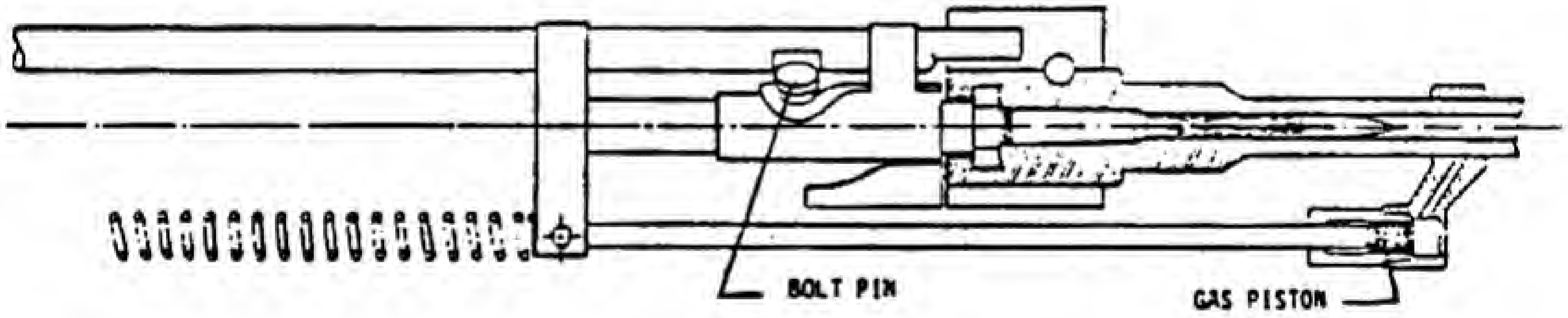
1. SEARED POSITION


BARREL
BOLT
GAS HOUSING

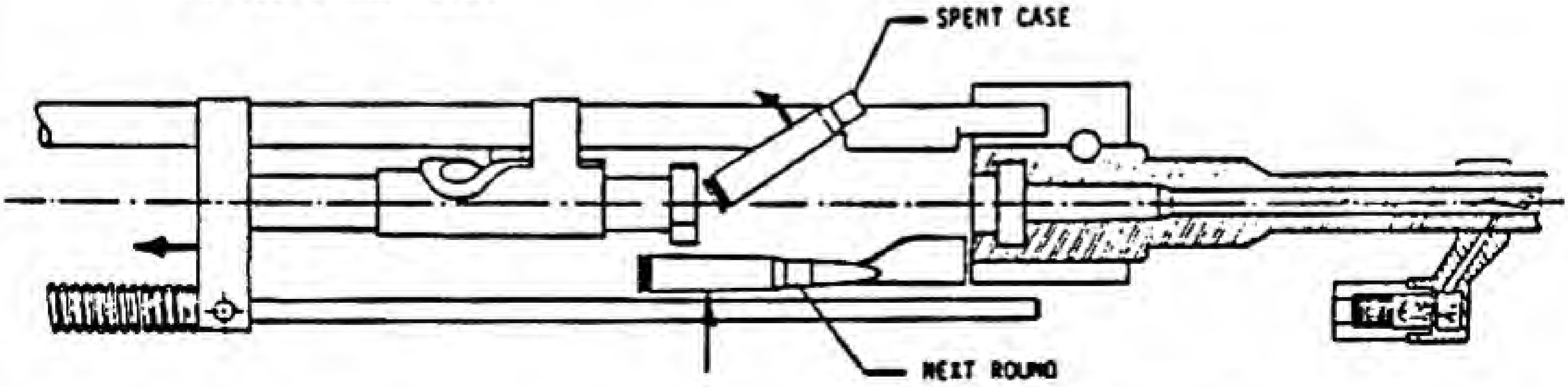
2. SEAR RELEASED


UPPER RECEIVER TUBE
RECEIVER
DRIVE SPRING
BOLT CARRIER
DRIVE ROD

3. ROUND IGNITION


BOLT PIN
GAS PISTON

4. BOLT CARRIER RECOIL


SPENT CASE
NEXT ROUND

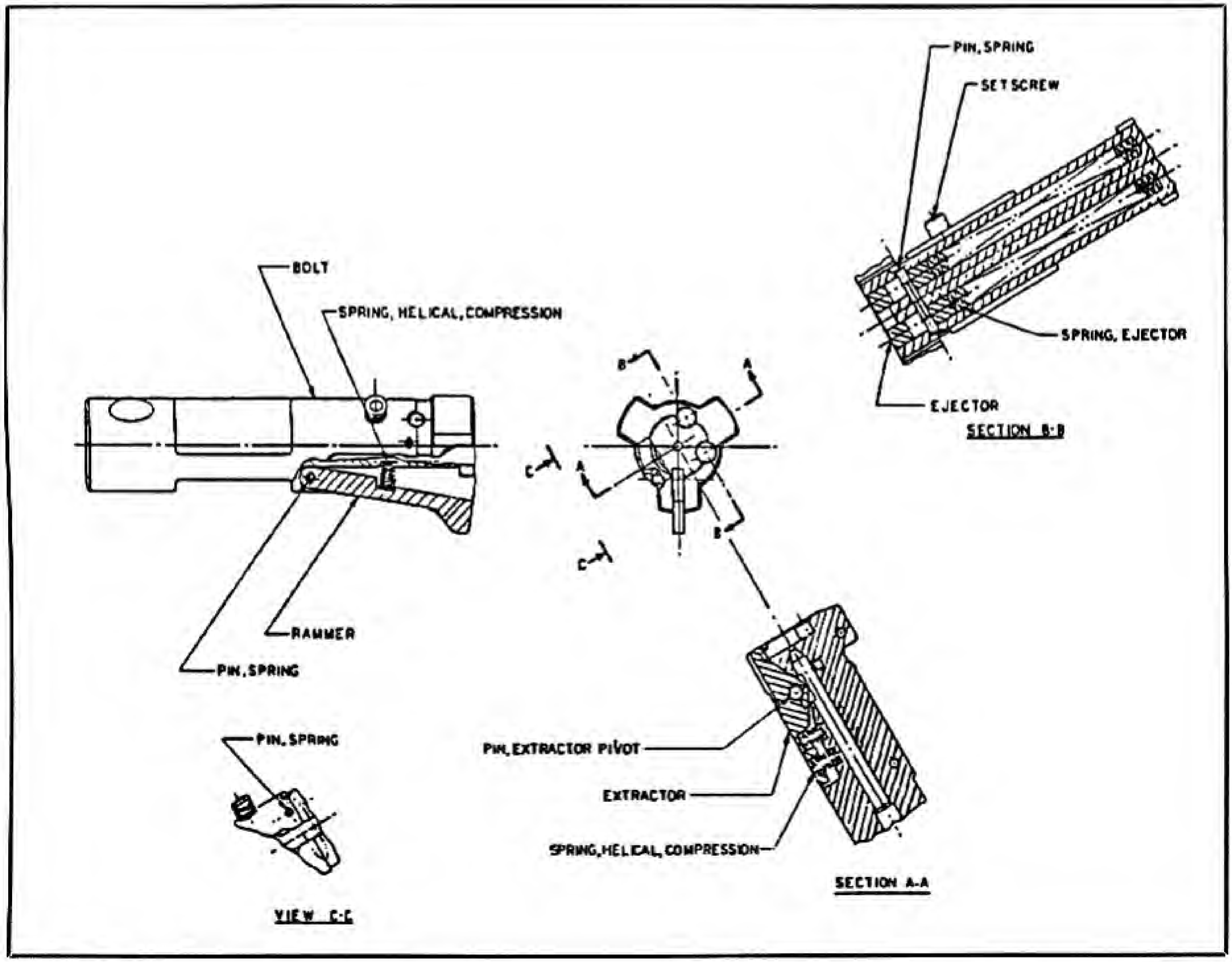
Calibre .50 Operational Sequence

other rotates with the feed cam, pulling the feed belt into position for the next cycle. When the spent cartridge case clears the breech, the ejector springs flip the case out through the ejection port. At the point where the carrier contacts the buffer, the feed sprocket will be in the proper orientation to begin another cycle. After buffer return, the carrier will either be stopped by the sear or will continue forward to begin the next cycle.

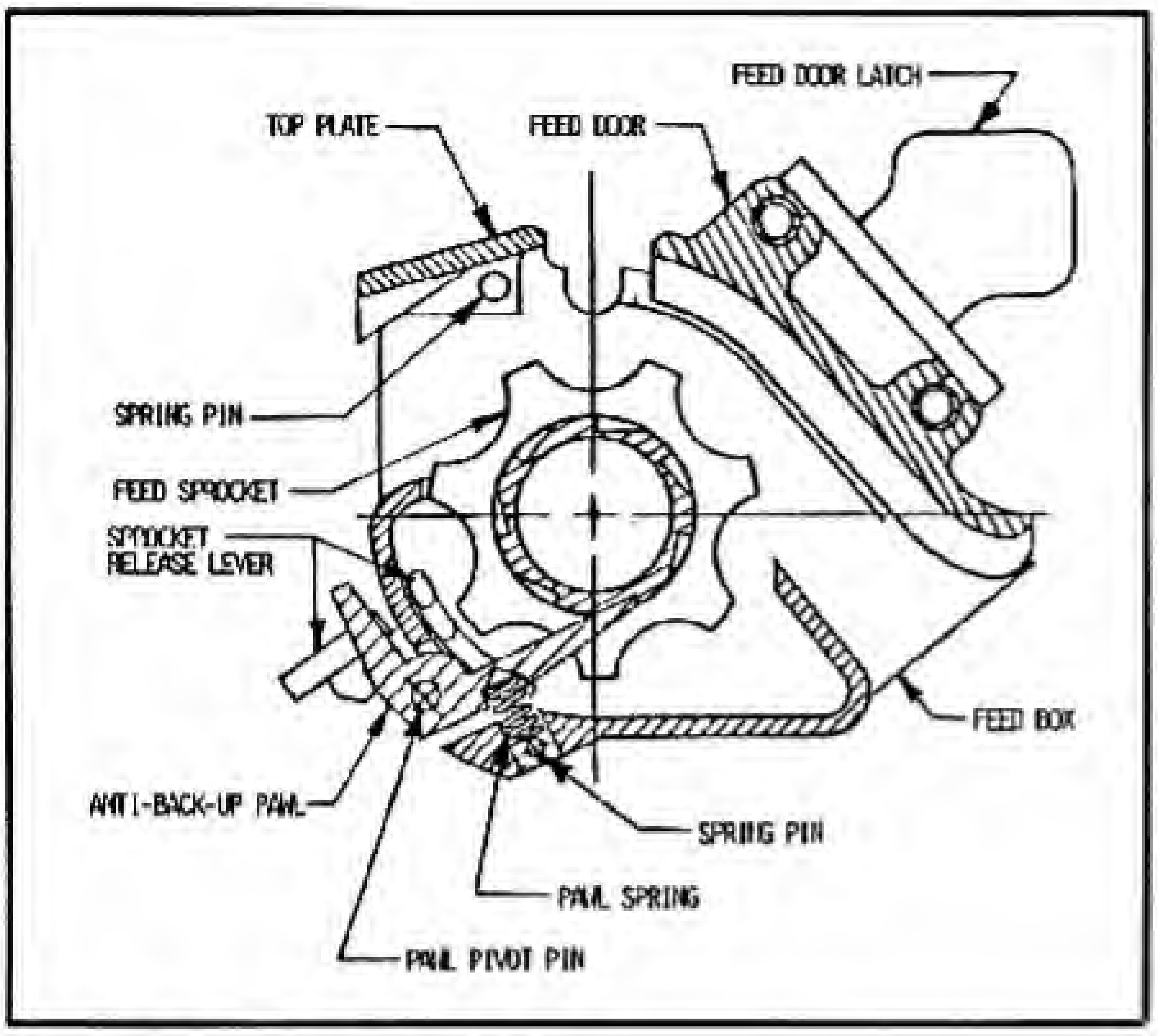
Counterrecoil Cycle. The counterrecoil part of the operational cycle is initiated with a charged and loaded weapon by placing the safety in the fire position, then depressing the sear pad at the rear of the sear assembly. Once the hook at the end of the sear clears the notch in the end of the bolt carrier, the operating assembly, under the influence of the drive springs, is accelerated freely forward contacting the cartridge in the feed box which is in position for stripping.

The rammer in the bolt assembly contacts the base of the cartridge causing the cartridge to be stripped out of the link as the operating assembly continues forward. Contact of the rammer with the base of the cartridge causes the bolt to retract into the bolt carrier for the distance of a short dwell at the forward (breech) end of the bolt carrier cam path. At this point, no further movement of the bolt within the bolt carrier can occur without rotation of the bolt which is prevented by the head of the cam pin which rides along the upper tube of the receiver.

The cartridge, forced out of the link by the rammer, rides up the feed ramp in the cartridge guide of the feed box assembly; it passes through the barrel extension into the chamber. Following the cartridge up the feed ramp, the rammer rides along


PIN, SPRING
SET SCREW
SPRING, EJECTOR
EJECTOR
SECTION B-B
BOLT
SPRING, HELICAL, COMPRESSION
B
A
C
A
B
C
RAMMER
PIN, SPRING
PIN, SPRING
VIEW C-C
PIN, EXTRACTOR PIVOT
EXTRACTOR
SPRING, HELICAL, COMPRESSION
SECTION A-A

Bolt Assembly


FEED DOOR LATCH
TOP PLATE
FEED DOOR
SPRING PIN
FEED SPROCKET
SPROCKET RELEASE LEVER
FEED BOX
ANTI-BACK-UP PAWL
SPRING PIN
PAWL SPRING
PAWL PIVOT PIN

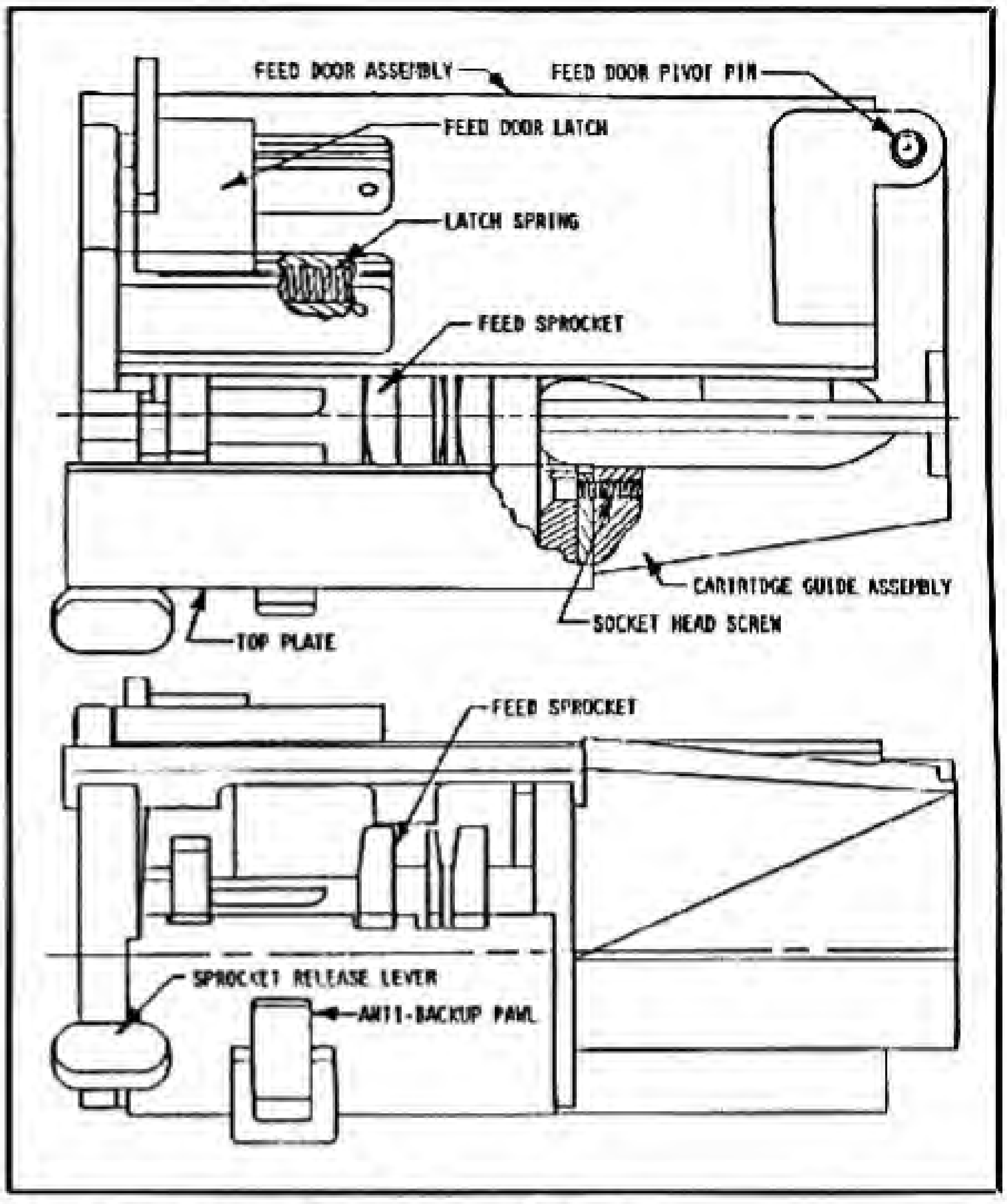
Feed Box Assembly Section

the steel insert in the ramp and is retracted into the bolt.

The cartridge is crushed slightly into the tapered shoulder interface within the chamber by the bolt. During this process, the extractor claw rides over the rim at the rear of the cartridge and is forced into the groove at the rear of the case by the extractor springs. The ejectors, riding against the base of the cartridge, are retracted into the bolt face.

At this point, the forward motion of the bolt ceases with the cam pin lined up with the window in the upper tube of the receiver and the bolt within the barrel extension. As the bolt carrier advances, the cam pin follows the cam path machined in the bolt carrier causing a counter-clockwise rotation of the bolt assembly. At the end of the cam path corresponding to a short section of cam dwell, the firing pin protrudes, contacting the primer which initiates the cartridge.

During the previously described forward motion of the operating assembly, the feed cam is rotated counter-clockwise by the interaction of the cam path with the feed cam roller which rotates about the drive pin at the rear of the operating assembly. As the feed cam rotates, the feed cam ratchet is retracted into the cavity within the feed cam. This retraction is a result of the interaction of the helix angles machined on both the feed cam ratchet and the ratchet teeth on the feed sprocket. Shortly before reaching maximum feed cam rotation the feed cam ratchet, under the influence of the compressed ratchet spring in the feed cam assembly, re-extends engaging the next set of feed sprocket ratchet teeth.


FEED DOOR ASSEMBLY
FEED DOOR PIVOT PIN
FEED DOOR LATCH
LATCH SPRING
FEED SPROCKET
CARTRIDGE GUIDE ASSEMBLY
SOCKET HEAD SCREW
TOP PLATE
FEED SPROCKET
SPROCKET RELEASE LEVER
ANTI-BACKUP PAWL

Feed Box Assembly - Top and Side View

Throughout the counterrecoil portion of the cycle of operation, the belt of ammunition is prevented from backing out of the weapon by the anti-backup pawl which engages the feed sprocket.

Recoil Cycle. Initiated by the primer, the burning propellant charge sends the bullet on its way down the bore. As the bullet passes the gas ports drilled through the gas housing and barrel, propellant gases fill the housing. Under the influence of the propellant gases, the two gas pistons move rearward contacting the ends of the operating rods. The load applied to the operating rods is transmitted to the bolt carrier through the drive pin, beginning the rearward movement of the operating assembly. While the bolt carrier is free to move for a short dwell at the rear of the cam path, tests have indicated that bolt rotation (unlocking) does not occur until the bullet has exited the barrel. Once the bullet exits the barrel, the operating assembly is free to move and the rearward movement drives the cam pin through the bolt carrier cam path causing a clockwise rotation of the bolt within the barrel extension.

At the limit of gas piston operating rod interaction, the gas pistons are stopped by stroke limiting spacers installed in the gas cylinders. From this point on, the operating assembly is no longer accelerated and is essentially in free recoil. Resistance to the movement of the recoiling components occurs as a function of friction, extraction, ammunition belt indexing (feed cam rotation), and the interaction of the drive springs being compressed by the recoiling components.

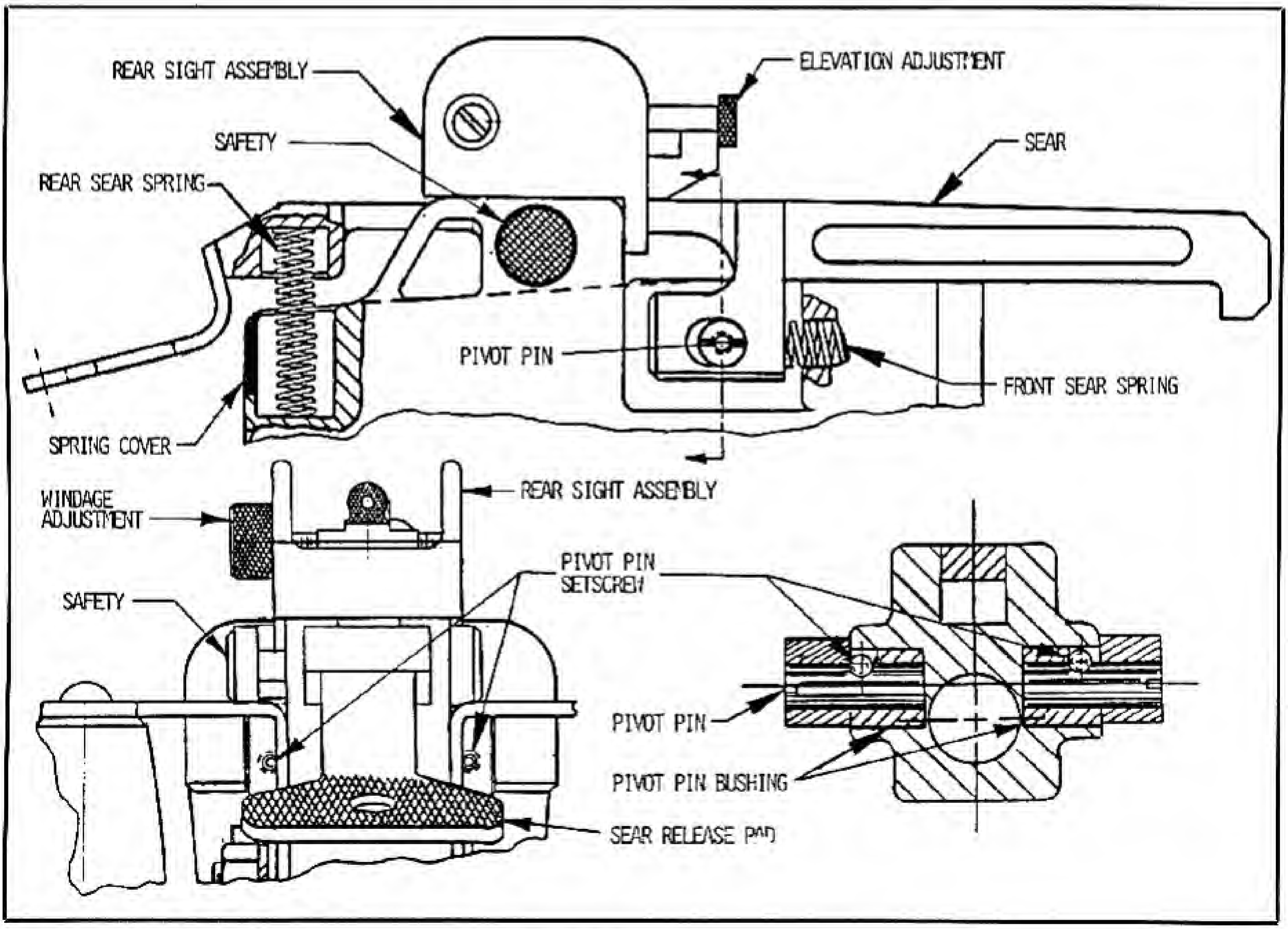
Upon reaching the end of the bolt carrier cam path, the unlocked bolt is picked up by the interaction of the cam pin and bolt carrier. Continued rearward movement brings about extraction of the spent cartridge case from the chamber, a result of the extractor claw pulling against the rear surface of the groove at the base of the cartridge case.

Exiting the chamber, the spent case is rotated about the case-extractor interface, a result of the spring-loaded ejectors pushing against the base of the case. Once the cartridge case is extracted beyond the barrel extension, it is ejected out of the right side of the weapon through the opening in the dust cover.

Along with extraction and ejection, the recoil action of the operating assembly, through the interaction of the feed cam roller and the linear harmonic cam path in the feed cam, causes the clockwise rotation of the cam and subsequently the feed sprocket. During this process, the clockwise sprocket rotation indexes the next round in the ammunition belt into the chambering position and pushes the previous link out the right side of the weapon.

Reaching the limit of feed cam rotation, the indexed round is prevented from over rotation by a round stop in the top plate at the rear of feed box assembly. The anti-backup pawl also re-engages its interface in the center section of the feed sprocket.

Shortly after the recoiling components pass sear position, the bolt carried contacts the hydropneumatic buffers in the backplate assembly which damp out any remaining energy. Recoil completed, the


REAR SIGHT ASSEMBLY
ELEVATION ADJUSTMENT
SAFETY
SEAR
REAR SEAR SPRING
PIVOT PIN
FRONT SEAR SPRING
SPRING COVER
REAR SIGHT ASSEMBLY
WINDAGE ADJUSTMENT
PIVOT PIN SETSCREW
SAFETY
PIVOT PIN
PIVOT PIN BUSHING
SEAR RELEASE PAD

Sear - Backplate Assembly

weapon will begin counterrecoil and will continue to function as long as the sear is depressed. If, however, the sear is released, the counterrecoil cycle will be halted by the action of the sear claw and the slot machined in the top of the rear yoke of the bolt carrier.

Test Results

The three calibre .50 weapons, delivered to the Government for additional testing, have been tested by AAI Corporation and deemed safe. Each weapon and all barrels have been proof tested with Government supplied proof rounds. After proof testing, all guns were disassembled and inspected for cracks by "magna-fluxing." A life cycle test of component parts has not been conducted on these weapons, and therefore, caution should be exercised if extensive firings are to take place.

AAI's "Safety Analysis and Hazard Evaluation Report" identifies the hazards and risk levels for this weapon system.

Additional safety information is available in AAI's Report "Safety Assessment Report."

CAUTION: If bolt is not fully closed because of an obstruction, do not remove obstruction and let bolt freely close on a live round, as weapon will fire. To clear weapon of a jam, pull back on the charging handle and put weapon in the "cocked" position with the safety "ON". Then clear obstruction and start firing sequence all over again.

Cook-off - It is believed that the cook-off level for this weapon is 290 rounds at continuous firing rate. This is based upon prior data with the M85 Machine Gun, which uses a similar barrel. It is recommended that the barrel be changed every 200 rounds when in the continuous firing mode.

Chapter 17

20mm AUTOMATIC CANNON

MAUSER MODEL B

20mm Automatic Cannon - Mauser Model B

History

Mauser developed a new high power propellant and a 20/23mm cannon system. This Mauser Bauer cannon is smaller and lighter than the M139 Hispano-Suiza HS820 20mm cannon used at that time. The ammunition is the same size and same length as the M139 HS820 20mm ammunition, but with the option of a 23mm projectile. The Mauser Model B ammunition and cannon system has more power than the 25mm cannon and ammunition system.

Description and Purpose

The Mauser Model B 20mm machine gun is an air-cooled, self-powered, open-bolt, gas-operated, belt-fed, weapon having a rate of fire of 900 rpm. It can fire either M50 series or HS 820 20mm ammunition, either electric or percussion primed.

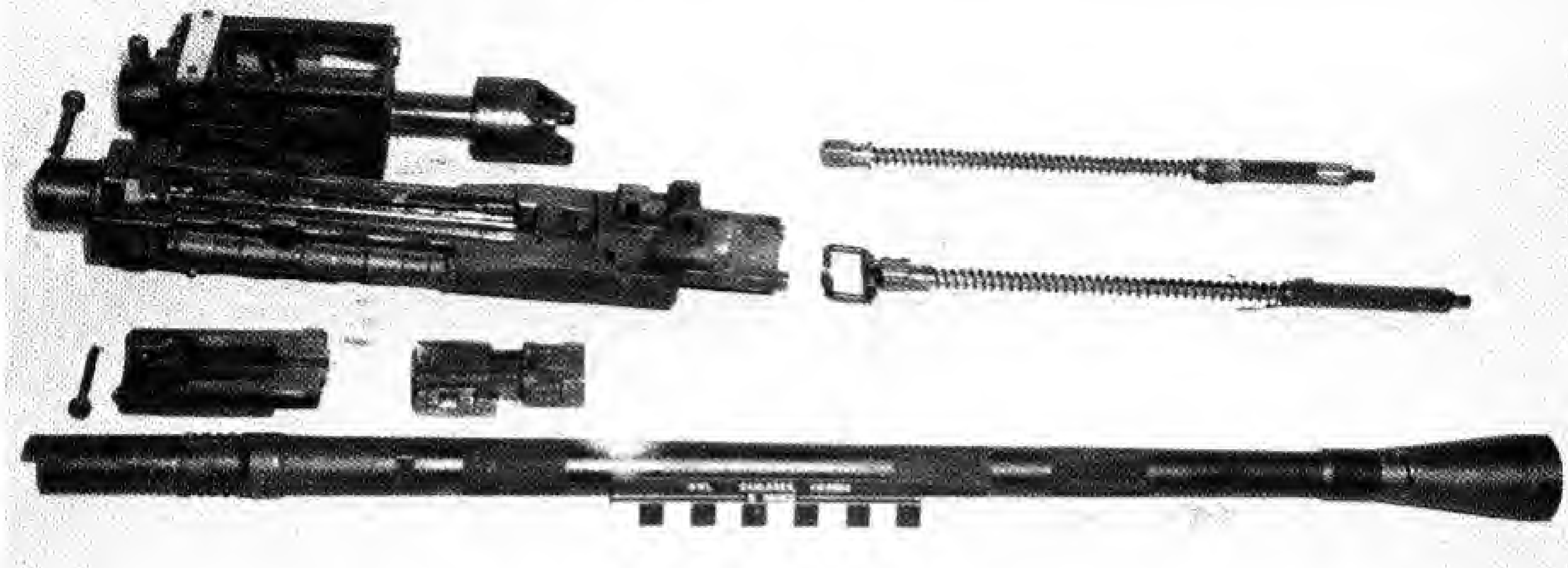
The basic weapon is designed to feed from the right, left or top using a gas and torsion-spring driver feeder. A gas driven piston cocks a torsion spring in the feeder drive which indexes the feeder during gun cycling. The rate of fire is continuously variable up to its normal rate. This is accomplished through the use of a hydraulic bolt retarding mechanism housed in the buffer. The weapon can be fired either electrically, by use of a solenoid, or mechanically with a trigger mechanism.

Electric primed ammunition can be fired without an external power source. A special bolt containing a piezo-electrical crystal generates sufficient EMF electric energy during forward travel of the bolt to fire the electric primer.

The weapon is mounted in a recoil-absorbing cradle, has a quick change barrel equipped with a flash hider, and can be field stripped easily without the use of tools.

Cycle of Operation

Trunnion recoil is taken up by two braided wire springs located in guide tubes along either side of the weapon's axis, to eliminate bucking. During continuous firing, the guide springs are constantly in varying degrees of compression and return the weapon to rest position only when firing is stopped. Soft-buffered support of this design reduces recoil forces to approximately one-half that normally experienced



20mm Mauser Model B Field Stripped

with hard-buffered design.

A simple trigger setting changes operation of the cannon from fully automatic to semi-automatic. In the semi-automatic mode, a single round is fired each time the trigger is depressed. When the bolt is in the scared position, a safety slide rigidly blocks the bolt, thus preventing accidental firing through severe jarring. In the automatic mode, rate of fire is continuous as long as the trigger is depressed. The recoiling bolt is returned forward by a plate-spring buffer supported by two laterally fixed locking springs. Initial cocking of the bolt can be accomplished manually, electrically, or hydraulically. The locking springs may be removed from the rear of the weapon while the bolt is readily accessible for removal by hinging the feeder mechanism.

Linked ammunition is accepted by a feed mechanism firmly attached to the weapon cradle by an easily operated locking mechanism. By anchoring the feed mechanism to the cradle, ammunition is independent of weapon recoil, and remains, in a longitudinal direction, at rest with respect to the ammunition supply. Positive cartridge feed is accomplished by a torsion spring driven sprocket located centrally within the feed mechanism. The torsion spring is cocked within a short travel at the beginning of breech recoil by a horizontally working gas piston located in the weapon housing. This arrangement separates the feed operation from recoil, making available for feed not only all the recoil time but also the time during which the buffer springs are relaxing. The additional feed time minimizes accelerative forces in the linked ammunition.

Current weapon feeder design accepts HS820 ammunition. A simple conversion enables the weapon to fire any linked, percussion fired, 20mm ammunition.

Test Results

At the Naval Weapons Laboratory, Dahlgren (NWL/D) there were four 20mm automatic guns. The gun tested was essentially a prototype and since an abnormally high stoppage rate was experienced; the Model B was not fully tested. The rest of this section is exerpted with minor editing from the actual report of that test.

Because of the high stoppage rate, 23 mean rounds between stoppages (MRBS) testing was discontinued after firing 2,360 rounds. The firing data shows that most of the stoppages were caused by failure of the weapon to feed properly. The torsion spring arrangement in the feeder drive failed repeatedly. Several minor modifications to the mechanism were made at the recommendation of company representatives but none was successful in improving the operation of the feeder. When firing brass-cased ammunition, cases stuck repeatedly and it was the second major problem area with the weapon. The design of the gas ports and chamber includes a chamber insert extending up to the crush-up shoulder area of the cartridge case. When brass cases were fired some of the case material apparently extruded into the gas port, causing the cases to stick in the chamber. When this happened, the extractor ripped the rim from the case base and the bolt would proceed to the rear without the case.

Additional problems were experienced when the weapon chambered a round but failed to fire. When this happened the bolt could not be drawn to the rear, even after manual release of the extractor from the case rim. The locks were stuck and required considerable force to dislodge the bolt and draw it rearward out of battery position. Examinations of the bolt after these incidents showed no unusual conditions nor any reason for bolt sticking.

Bending of links in the feeder was also a frequent problem with this weapon. Because of the design of the feed tray, the link sometimes extends down into the tray opening when the round rolls into feed position in the feeder. When the bolt moves forward to ram the round from the link, the bolt hits and bends the link.

Other feeding, extracting, and ejecting difficulties were occasionally experienced.

The driving springs were changed, the gas ports cleaned frequently, the ammunition lubricated and parts interchanged between the two test weapons in an attempt to improve the gun performance. These efforts were all unsuccessful. As a further measure, German manufactured links were used to replace the XM24 link but the link bending and related feeding problems persisted. HS820 ammunition was also fired in the weapon but this did not improve performance. Bent links, failures to feed and eject properly, and stuck cases were as predominant with the HS820 as with the M50 series ammunition.

Although evaluation of the Mauser Model B was discontinued because of the poor performance, the limited testing did successfully demonstrate operation of the hydraulic rate reducer and piezoelectric bolt which are unique features of the design. Both of these features could be desirable if included in a basically sound gun system.

This report concluded that the Mauser Model B has major problem areas in its present configuration. Further investigation continued to determine the exact nature and extent of the deficiencies of the system, and to determine whether or not the weapon will be useful to the U.S. Navy in any capacity in the future.

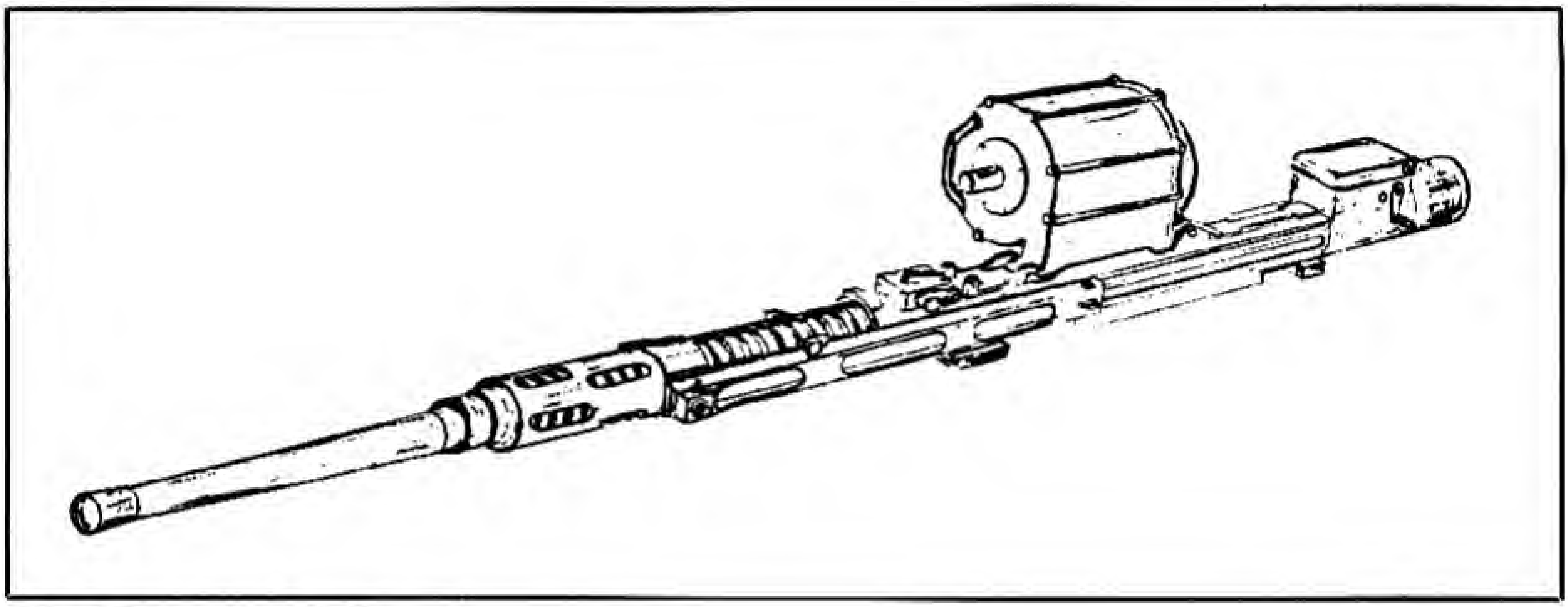
Characteristics

Weights:	
Complete Weapon without Barrel	90.2 lb.
Barrel with Flash Suppressor	46.2 lb.
Cartridge	.325 lb.
Belt Link	.112 lb.
Cradle, Complete	29.04 lb.
Ultra-light Cradle Complete with Hand Cocking Device (Gun Mount for Ground Fighting, Helicopter)	24.5 lb.
Dimensions:	
Length of Weapon with Flash Suppressor	96.53 in.
Barrel Length	72.5 in.
Length of Weapon without Barrel	30.28 in.
Length from Rear End of Cartridge Inlet to Rear End of Weapon	11.61 in.
Cocking Stroke of Bolt	12.40 in.
Cross Dimensions:	
Height	10.39 in.
Width	8.86 in.
Miscellany:	
Rate of Fire	900 to 1050 r.p.m.
Recoil Forces	1364 lb. max. 704 lb. min.
Recoil Travel	1.26 in. min.
Floating Travel	0.55 in. to 0.71 in.
Triggering Force	57.2 lb.
Belt Pulling Forces during Firing	220 lb.
Belt Lift (Vertical)	78.74″ min.
Ammunition:	
Calibre	20mm
Length of Cartridge	8.39 in.
Weight of Projectile	.264 lb.
Muzzle Velocity	3,444.8 ft./sec.
Maximum Gas Pressure	48,621 psi

Chapter 18

30mm Mk 4 AUTOMATIC GUN

HUGHES TOOL COMPANY (Presently McDonnell Douglas) and the NAVAL GUN FACTORY VERSION



30mm Automatic Gun Mk 4

History

During the early 1950's, development of this weapon was conducted in parallel programs at both Hughes Tool Company and the Naval Gun Factory under Bureau of Ordnance sponsorship. Overall objectives included conversion of the 20mm Mk 12 gun to a long-barrel version capable of firing the "then existent" 30mm Aden round, and the development of a new design 30mm short-barrel gun for turret installations. For a variety of reasons program development was terminated in the late 1950's and no additional effort was ever pursued. All weapons built during the program were delivered to the Navy.

This exercise was done for the purpose of developing a "Hispano-type" gun to fire the 30mm Aden round of ammunition. It was related to the T154 program for the development of turret weapons for bomber defense.

The 30mm Mk 4 gun is a scaled up version of the 20mm Mk 3 Hispano-Suiza gun. Overall length was 75 inches for one version which weighed 115 pounds and had a rate of fire of 1050 rpm with a muzzle velocity of 2850 fps.

The 30mm Mk 4 gun is identical in every detail to the Mk 3 (most of the work was accomplished with modified Mk 12 receivers). However, there were some differences between the Hughes and Naval Gun Factory versions. Hughes utilized a dead receiver concept while NGF pursued the more conventional Hispano design. Both "contractors" had a long-barrel and a short-barrel version which were identified as Mk 4 Mod 0 and Mk 4 Mod 1 respectively.

An Mk 1 pneumatic feed mechanism was developed as a part of the program and the design was similar to the 20mm Mk 7 feeder. Gun and feeder

Characteristics

Calibre	30mm
Action	Hispano type
Feeder	30mm Mk 1 (modification of 20mm Mk 7 pneumatic feeder)
Operation	Blowback, Gas Unlock
Rate-of-Fire	1000-2000 rpm
Barrel Lengths	52.5 in. and 31.5 in.
Ammunition	Aden 30mm T158 (Frankford Arsenal)
Link	30mm Mk 1 (based on features of the 20mm M2 and M8E1 links)

were designed for a firing rate of 1000-1200 rpm and the system was to be interchangeable in mounting with the 20mm Mk 12.

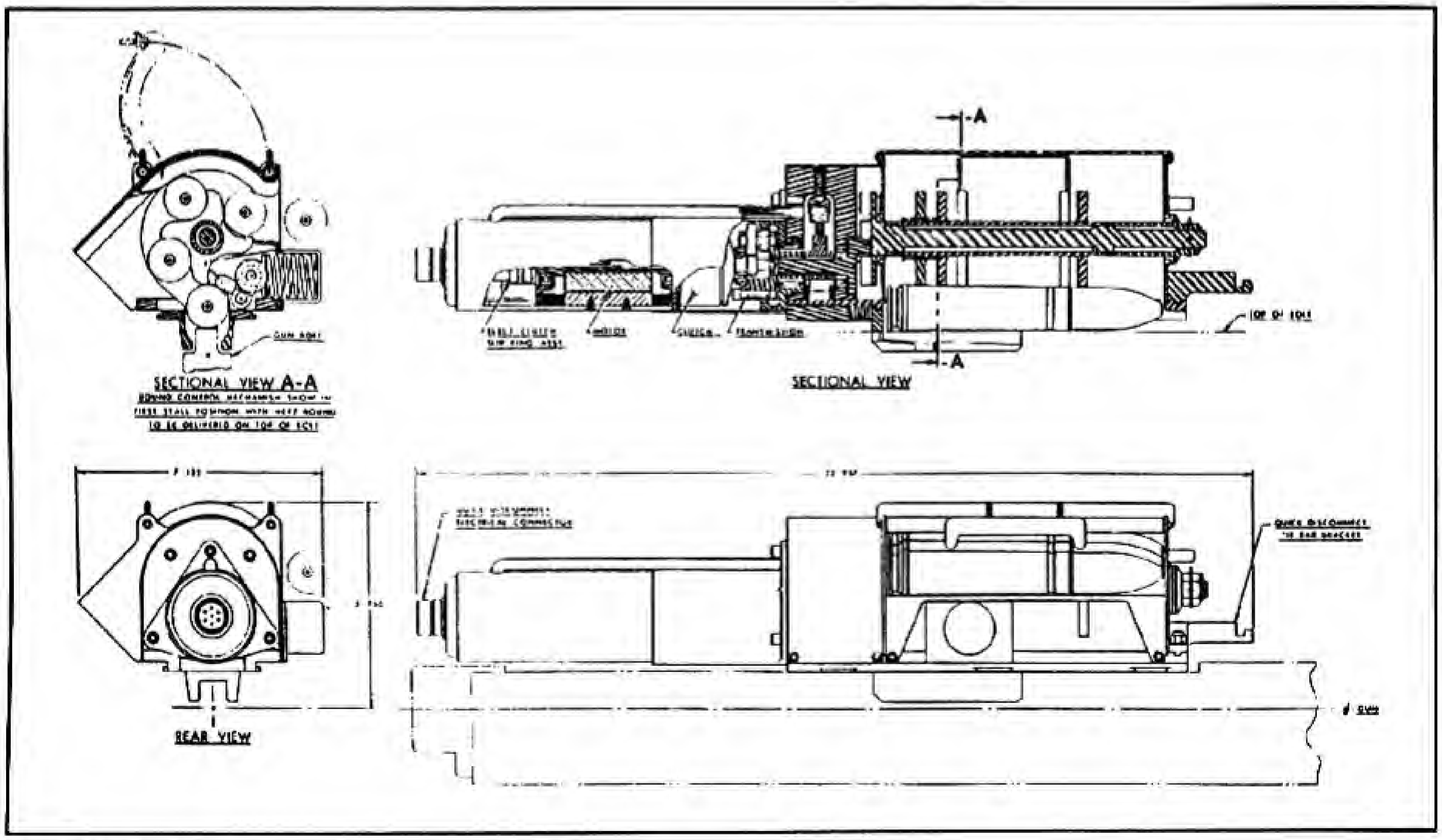
A 30mm Mk 1 link which combined features of both the M2 and M8E1 20mm links was developed as part of the basic program.

Cycle of Operation

To fire the 20mm Hispano-Suiza (Birkigt) automatic gun, the operator must first see that each cartridge case has been liberally lubricated before being placed into the magazine, after which the loaded magazine is snapped into position on top of the receiver. Spring pressure positions the first round on top of the bolt, which is in battery.

The charging assembly is then pulled completely to the rear or until the sear is securely engaged in its recess under the bolt body. Upon release, the charging unit goes home under its own spring tension. The passing of the bolt rib under the feed mouth allows the incoming cartridge to drop a fraction of an inch for final positioning.

The gun is now in the cocked bolt position and release of the sear allows the driving spring to force the bolt and its components forward. As the front face of the bolt passes under the rear of the feed mouth, it engages the rim of the cartridge, forcing it down into the extractor claws, and continues to push it towards the chamber. Continued travel completes the seating of the cartridge and the forward motion of the bolt is finally stopped by contact with the barrel and receiver. At the instant of impact the breechblock lock is cammed downward into locked position against its locking key and held securely by



Feed Mechanisms

A simplified, lightweight, high torque electric feed mechanism for installations where profile of gun with feeder must be kept low. Interchangeable with Mk 1 pneumatic feeder.

DIMENSIONS

Length	24.0 inches
Height	4.75 inches
Width	7.125 inches

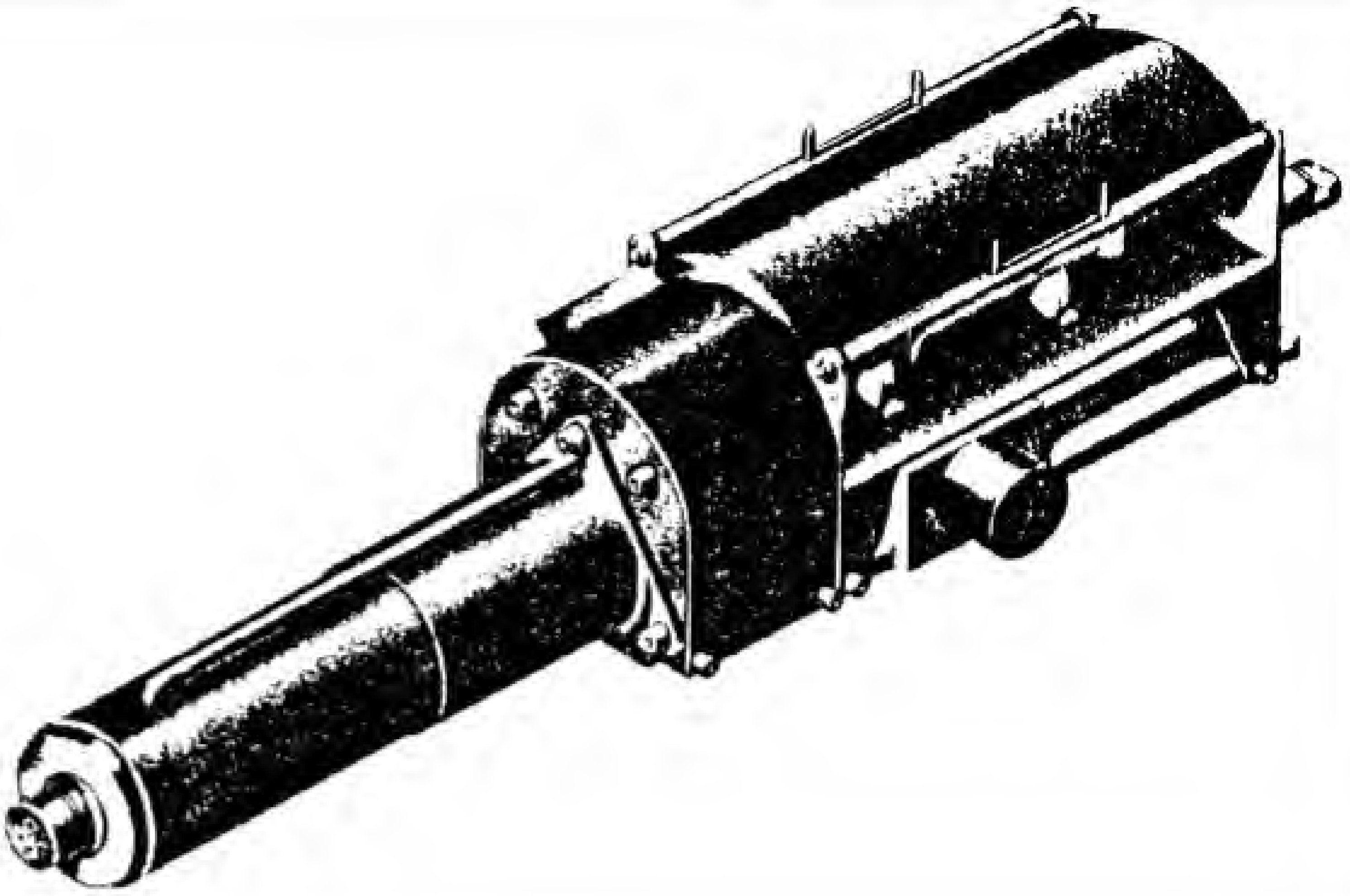
WEIGHT	20 pounds

POWER REQUIRED (No booster necessary)

Motor	200 volts, 3-phase, 400 cycles, 1500 watts
Clutch	28-volt dc, 50 watts

ROUNDS PER MINUTE

Up to 1250 rpm at 100-pound belt load



Low Profile Electric Feed Mechanism

the continued travel of the slides.

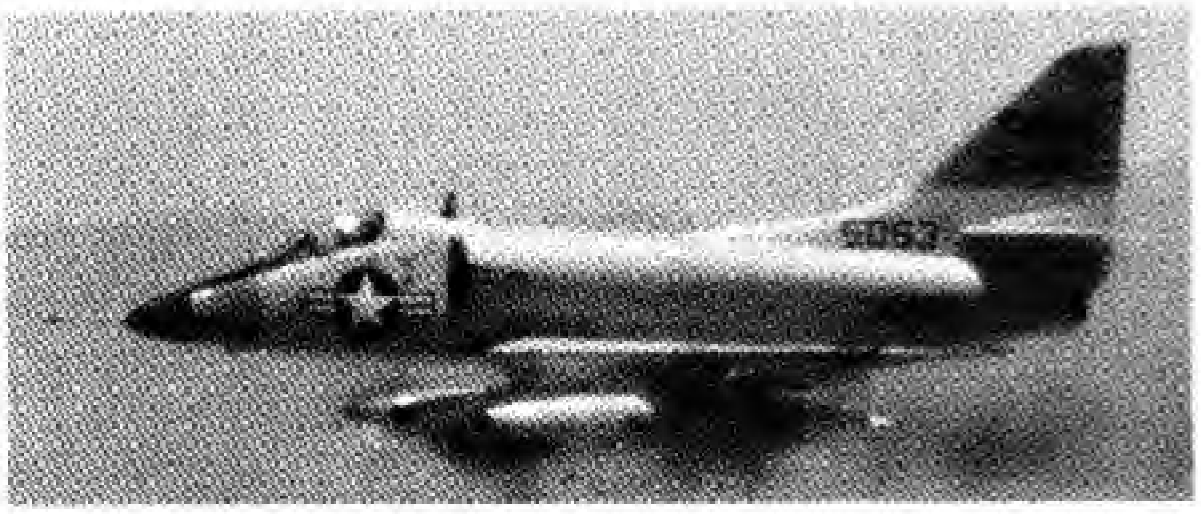
The latter, which are connected through the bolt body by means of a key that carries the firing pin, are now driven on by the combined action of the breechblock-slide springs and the inertia of the entire assembly, causing the firing pin to strike the primer. The powder charge in the cartridge is thereby ignited. The bolt is positively locked at the instant of firing and remains that way until the projectile has passed the port in the barrel, at which point gas is bled into the cylinder that houses the actuating piston.

As soon as the gas piston moves to the rear, its yoke contacts two push rods that in turn engage the slides through the receiver body. The movement of the slides retracts the firing pin for a stroke of three-fourths inch. It also permits the breech lock to rise and unlock after the projectile has cleared the bore, while a high residual pressure still is present to drive the bolt rearward.

The lubricated cartridge case is now floating in the chamber and when the breech lock is suddenly raised, the remaining chamber pressure is brought to bear on the face of the bolt. The latter starts to the rear with the extractor acting merely as a guide and support under the empty cartridge case. When the bolt face passes beneath the feed mouth, the ejector prongs strike the rim of the empty case pivoting it downwards through the ejection slot in the bottom of the receiver and the spring tension in the feed, positions another round for chambering. The bolt continues to travel rearward, compressing the driving spring. At the end of the recoil stroke, it strikes the rear buffer. The latter returns the bolt in counter-recoil to repeat the cycle of operation if the sear remains depressed.

Test Results

During the 1957 Air Force tests, the gun was found unacceptable for turret installations.



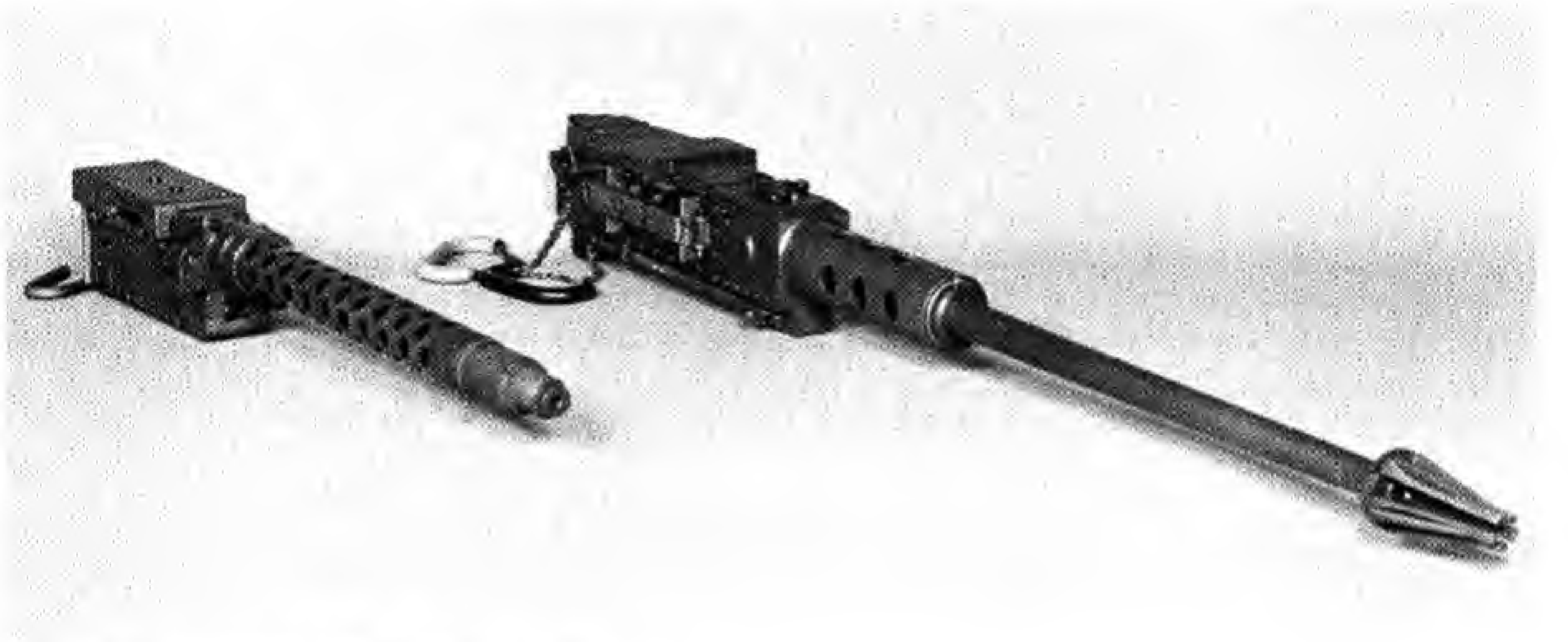
Mk 4 Mod 0 Gun Pods on A-4 Aircraft

30mm U.S. Aden/Defa Ammunition used in the Mk 4. (Photo courtesy of Woodin Laboratories.)

Chapter 19

7.62mm TANK MACHINE GUN T197, M73, M73E1, and M219

SPRINGFIELD ARMORY



7.62mm M73 and Calibre .50 M85 Machine Guns

History

The M73 Machine Gun was designed as a coaxially mounted gun specifically to fit between the breech ring of the 105mm cannon and the mantlet of the M60 tank. The space dictated the size and shape of the gun mechanism. Richard Colby of the U.S. Springfield Armory designed the mechanism.

The military characteristics for this gun were established at a conference held at Fort Knox, Kentucky, in October 1950. The Research and Development work was begun in February 1951, stopped in June 1953, and resumed in May 1956.

This new machine gun was to meet the following considerations:

a. Recoil operated.
b. Air cooled.
c. Contain a short receiver.
d. Cyclic rate to be 350-600 rounds per minute.
e. Have a right or left-handed feed.
f. Quick-change barrel with fixed head space.
g. Of approximately .30 calibre.

Four designs, T197, T198, T199 and T200, were considered with the T197 being selected for further development and refinement resulting in the T197E2 in February 1958. In May 1959 the T197E2 was type classified standard "A" and designated the M73 Machine Gun.

Initial delivery scheduled for June 1960 was delayed until October 1960 because of low recoil energy and separated cartridge cases. In 1960-62 Springfield Armory developed the booster modification to the M73. It consisted of new case carrier grips,

Characteristics

Model	M73
Caliber	7.62mm
Weight of Gun (Complete)	28 pounds
Weight of Barrel	5 pounds, 10 ounces
Overall Length of Gun	37¾ inches
Overall Length of Barrel	22 inches
Overall Width of Gun	4-13/32 inches
Overall Height of Gun	5-5/16 inches
Method of Operation	Recoil (gas booster assist)
Method of Cooling	Air
Rate of Fire (rigid mount)	350-600 spm
Direction of Feed	Either side
Headspace	Fixed
Method of Charging Gun	Manual Charger
Method of Firing	Manual or Solenoid
Case Ejection	Bottom of Receiver
Link Ejection	Side of Receiver
Type Link (M13)	Push through, metallic
Type Flash Hider	Cone
Accuracy	Nine shots of a 10-round burst shall group within or cut the edge of a 10.8 in. dia. circle at a range of 100 yards

Ammunition:
- Cartridge, 7.62mm, ball, NATO, M59
- Cartridge, 7.62mm, high pressure, NATO, M60
- Cartridge, 7.62mm, AP, NATO, M61
- Cartridge, 7.62mm, tracer, NATO, M62
- Cartridge, 7.62mm, dummy, NATO, M63
- Cartridge, 7.62mm, ball, NATO, M80
- Cartridge, 7.62mm, blank, NATO, XM82

spring and link, new booster, and extended stillite liner (barrel). This booster modification has been incorporated into weapons produced after January 1963.

Description

The weapon is air cooled, recoil operated with a muzzle booster to assist. The barrel is a stellite lined, quick change, fixed headspace, heavy barrel. The weapon fires from the open bolt and the rate of fire is 500 to 625 spm.

The basic mechanism which forms the recoiling mass consists of the barrel extension group and the heavy barrel. The barrel extension contains the breech block, rammer assembly, lever assembly and other miscellaneous parts. The barrel extension is shaped to receive a groove on the breech end of the barrel thus fastening the barrel to the barrel extension. The breech block is carried by the barrel extension and moves transversely when the barrel extension moves through the recoil/counter recoil cycles.

The M73 MG differs from the M73E1 MG in the way the fired cartridge case is ejected from the receiver. On the M73 there is a gripper mechanism that is carried on the lever assembly in the barrel extension which would grip the empty cartridge case on the recoil stroke, rotate about a pivot pin on the lever mechanism and eject the fired case on the counterrecoil stroke of the barrel extension.

This mechanism suffered some reliability problems and in 1961 a project was initiated at Springfield Armory to develop fixed ejectors. The fixed ejectors were incorporated into the bottom of the feed tray and this weapon was designated the M73E1.

The M219 Machine Gun is basically the M73E1 with improved opening and closing cams in the receiver.

The U.S. Springfield Armory first produced the M73 Machine Gun. The General Electric Company, Springfield, Massachusetts produced more than 3000 M73E1 machine guns. Rock Island Arsenal produced the M219 Machine Guns.

M73E1 Cycle of Operation

When the trigger is depressed, either manually or electrically, the sear is depressed releasing the barrel extension group to be driven forward by the two drive springs. As the barrel extension moves forward, the roller on the lever assembly engages the fixed closing cam in the side of the receiver. This causes the lever to rotate about the pivot pin at the bottom of the lever and barrel extension. The lever carries the rammer assembly forward and pushes a cartridge through the metallic belt link that is in the feed tray.

The round continues forward into the barrel chamber, the extractor moves and engages the cartridge case extraction groove as the barrel extension continues forward. The roller on the bottom of the breech block engages a cam fixed in the front end of the receiver. This cam causes the breech block to move laterally and locks the breech shut.

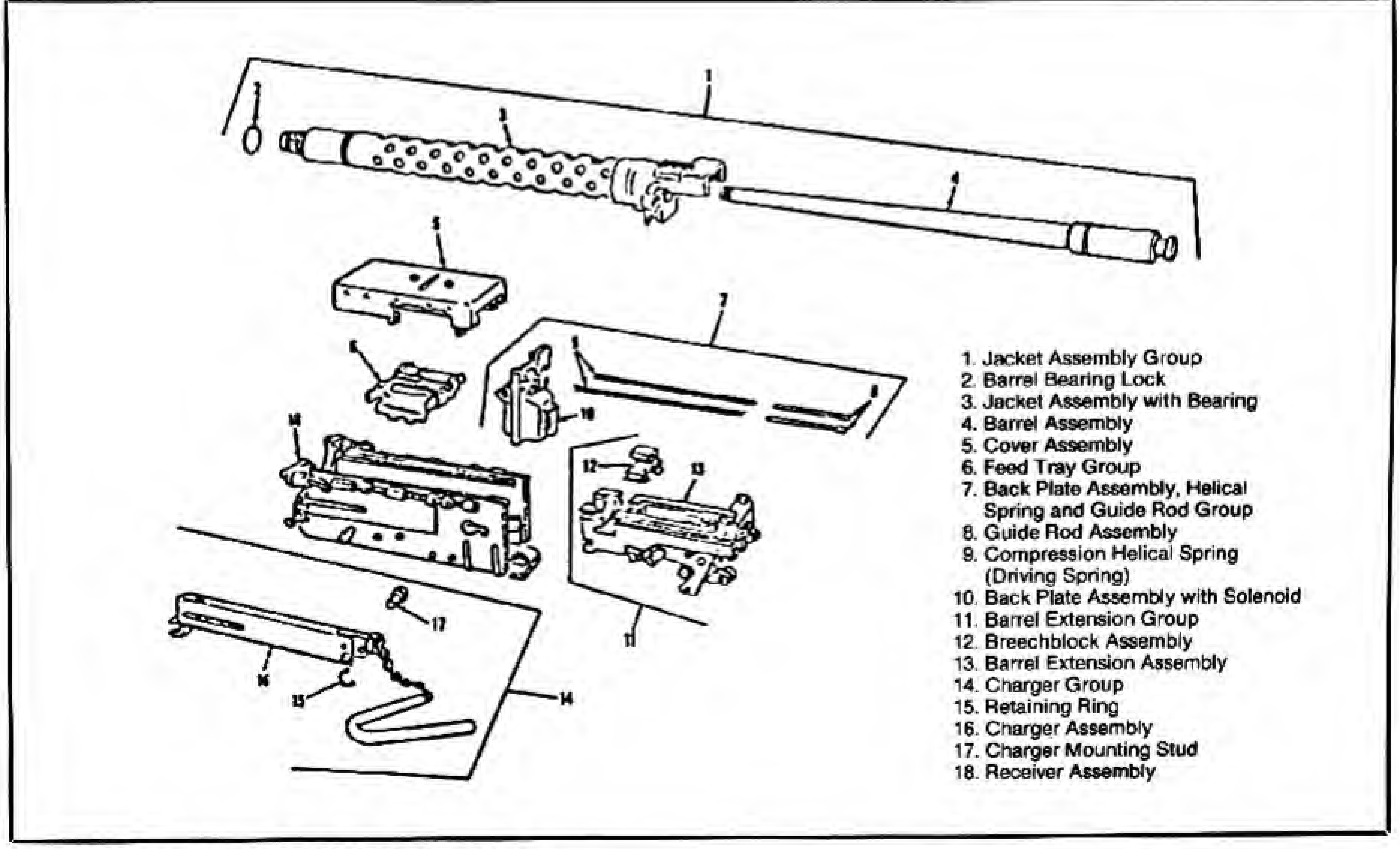
The forward motion of the barrel extension causes the pawl to engage the slide and move it forward compressing the spring. When the slide reaches the forward position it is released from the pawl assembly and it travels to the rear under spring pressure until it strikes the sear, releasing the spring loaded hammer to rotate and strike the firing pin extension and firing pin. The function of the slide mechanism is to provide a time delay and reduce the rate of fire from 800 spm to 500 spm.

When the cartridge fires, the recoil impulse starts the barrel and barrel extension moving toward the rear and is assisted by the action of the gas pushing against the face of the barrel at the muzzle where the barrel jacket acts as a gas cylinder. As the barrel extension moves rearward, it cocks the hammer. The roller on the breech block engages the cam fastened to the receiver. The cam path forces the breech roller to carry the breech block to the right and out of the way of the rammer assembly. The rammer assembly, which also incorporates the extractor, moves rearward with the lever assembly until the roller on the lever engages the opening cam on the receiver. This cam accelerates the lever rearward causing the spent case to be extracted from the barrel chamber. The lever continues rearward and the spent case strikes the fixed ejectors on the bottom of the feed tray causing the case to spin out of the receiver. The barrel extension compresses the two drive springs and then strikes the buffer which stops its rearward motion. If the trigger is released, then the barrel extension will engage the trigger sear and be held rearward stopping the firing. If the trigger is still depressed, the gun will continue to fire.

Test Results

Extensive test results are available on the M73 series and no attempt will be made to summarize them all.

"After testing at Aberdeen Proving Ground by the U.S. Army Armor and Engineer Board (then U.S. Army Arctic Test Board), the T197E2 machine gun was type classified Standard A on 14 May 1959. The performance of the weapon was never entirely satisfactory and product improvement and testing continued. After receiving complaints from U.S. Army Europe (USAREUR) troop units, a "field fix" and selection of ammunition lots which were compatible with the M73 were instituted in 1962 to correct the unsatisfactory performance of the weapon. In addition, Springfield Armory continued product improvement and in December 1964 submitted the M73E1 machine gun for engineering test by U.S. Army Development and Proof Services and service test by the Armor and Engineer Board. Develop-


1. Jacket Assembly Group
2. Barrel Bearing Lock
3. Jacket Assembly with Bearing
4. Barrel Assembly
5. Cover Assembly
6. Feed Tray Group
7. Back Plate Assembly, Helical Spring and Guide Rod Group
8. Guide Rod Assembly
9. Compression Helical Spring (Driving Spring)
10. Back Plate Assembly with Solenoid
11. Barrel Extension Group
12. Breechblock Assembly
13. Barrel Extension Assembly
14. Charger Group
15. Retaining Ring
16. Charger Assembly
17. Charger Mounting Stud
18. Receiver Assembly

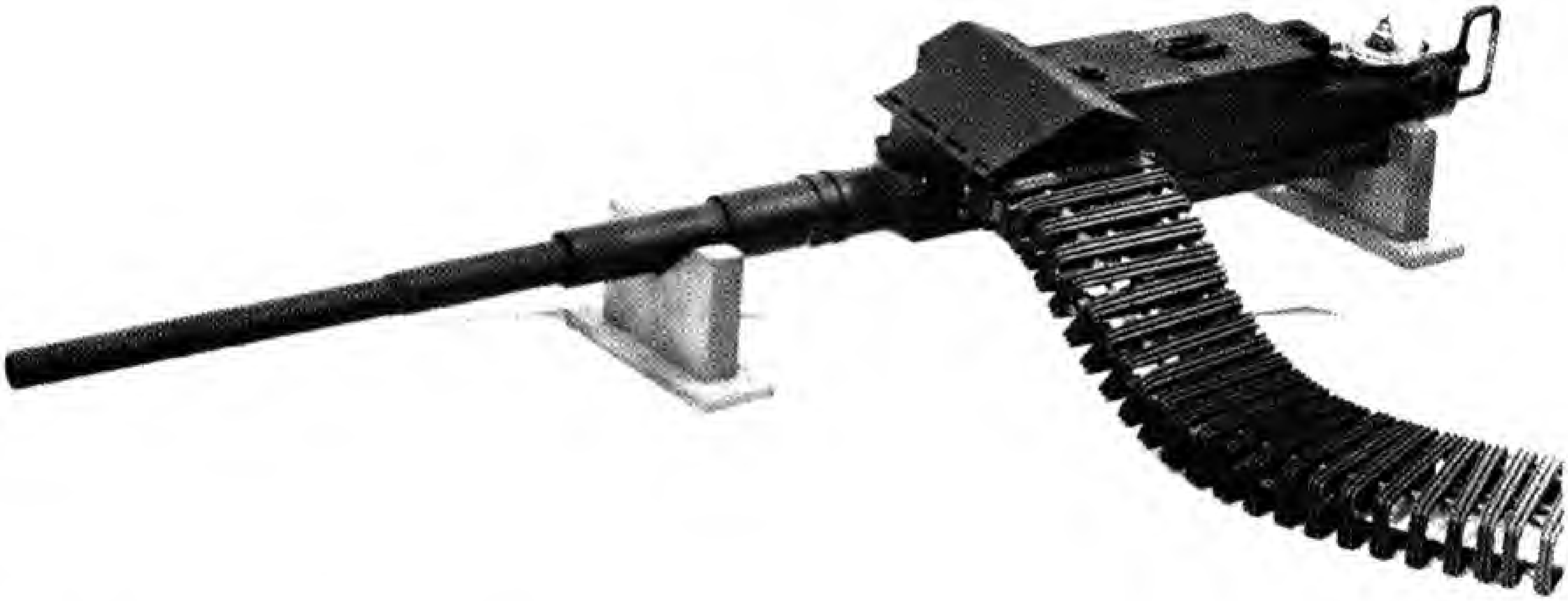
Exploded View 7.62mm M73E1 Machine Gun

ment and Proof Services concluded from the results of this engineering test that despite obvious advantages in producing and maintaining the M73E1 machine gun, advantages in clearing of stoppages, and satisfactory performance of the blank firing adapter, the gun's performance under most combat type conditions compared unsatisfactorily with that of the standard machine gun. Development and Proof Services recommended that if further production of M73 machine guns were to be undertaken, further improvement should be made and the modified E1 design be resubmitted for test. Based on these conclusions and recommendations U.S. Army Test and Evaluation Command recommended to U.S. Army Weapons Command that the M73E1 machine gun would not be accepted until its reliability had been proven in a confirmatory test to be conducted by the Armor and Engineer Board using 17 M73E1 machine guns with adequate spares, in a Fort Hood TOE unit and further recommended that the tube and bar flash suppressor be adopted for use in M60A1 tanks. Based on the USATECOM position and a 20 July 1965 request from the Assistant Chief of Staff for Force Development for evaluation of complaints from USAREUR on the unsuitability of the M73 machine gun, U.S. Army Material Command directed expedited test and approval of the M73E1 machine gun as a matter of urgency. As a part of this action, U.S. Army Weapons Command requested that an arctic test be conducted during the 1965-66 test season. A safety release was issued on 12 March 1965.

During development tests at Springfield Armory, some difficulty was experienced with LSA (MIL-L-4600) as a low temperature lubricant. This was confirmed in a lubrication trial preceding the engineering test at Development and Proof Services, Aberdeen Proving Ground. Neither the M73 nor M73E1 guns would operate when LSA was used as a lubricant. Therefore, another lubricant was used as a lubricant during the cold test at Development and Proof Services. The trouble was attributed to the rate reducer mechanism. For this reason, the rate reducer mechanism was removed and attention was focused on lubricants and lubrication procedure under arctic winter conditions. The Machine gun, 7.62mm, Fixed Ejector: M73E1 (without rate control) was redesignated the machine gun, 7.62mm, Tank: XM161 in item number 4374 by action of the Army Material Command Technical Committee during Meeting Number 4-66, 27 April 1966."

Chapter 20

20/30mm Mk 22 AUTOMATIC MACHINE GUN
NAVAL ORDNANCE STATION LOUISVILLE



20/30mm Mk 22 Automatic Machine Gun

History

The U.S. Navy initiated a research program during the early 1950's to investigate the best approach in the field of automatic weapons for aircraft and anti-aircraft use. The purpose was to determine the feasibility of combining superior features and well known principles with advancements in ballistics and metallurgy, to produce in a simpler and more reliable automatic weapon than was in use or contemplation.

One primary aim was to eliminate gas operation and ram feeding. This program led to the development of the EX-6 20mm/30mm machine gun. Initially, it was the task of the U.S. Naval Ordnance Station in Louisville, Kentucky (NOSL).

In 1953, the fabrication and testing of the EX-6 machine gun was turned over to the U.S. Naval Aviation Ordnance Test Station in Chincoteague, Virginia.

The "composite machine gun," EX-6 was also built and successfully tested by the U.S. Navy at the Navy Proving Ground in Dahlgren, Virginia. This gun did not use ram type feeding, and it maintained full mechanical control of the round from feeder entry to firing and ejection. Although the EX-6 prototype fired satisfactorily additional design changes and refinements were still desired. However, further work on the EX-6 was postponed after the Korean War.

In August 1967, after establishing this gun as the best prototype in existence, a decision was made to pursue the EX-6 Machine Gun. On 6 September 1967, NOSL received $200,000 to investigate

20/30mm gun mechanisms. A mechanical feeder similar to the feeder used on the Mk 19 grenade launcher was to be utilized instead of a gas feeder. The decision to follow the original EX-6 design was based on the following points:

- It does not utilize ram-type loading.
- It does away with gas operation.
- It is adaptable for high or low firing rates.
- The in-line action eliminates bending and reduces trunnion loads.
- It does not use an extractor or ejector.
- It has an inexpensive, stamped steel receiver.

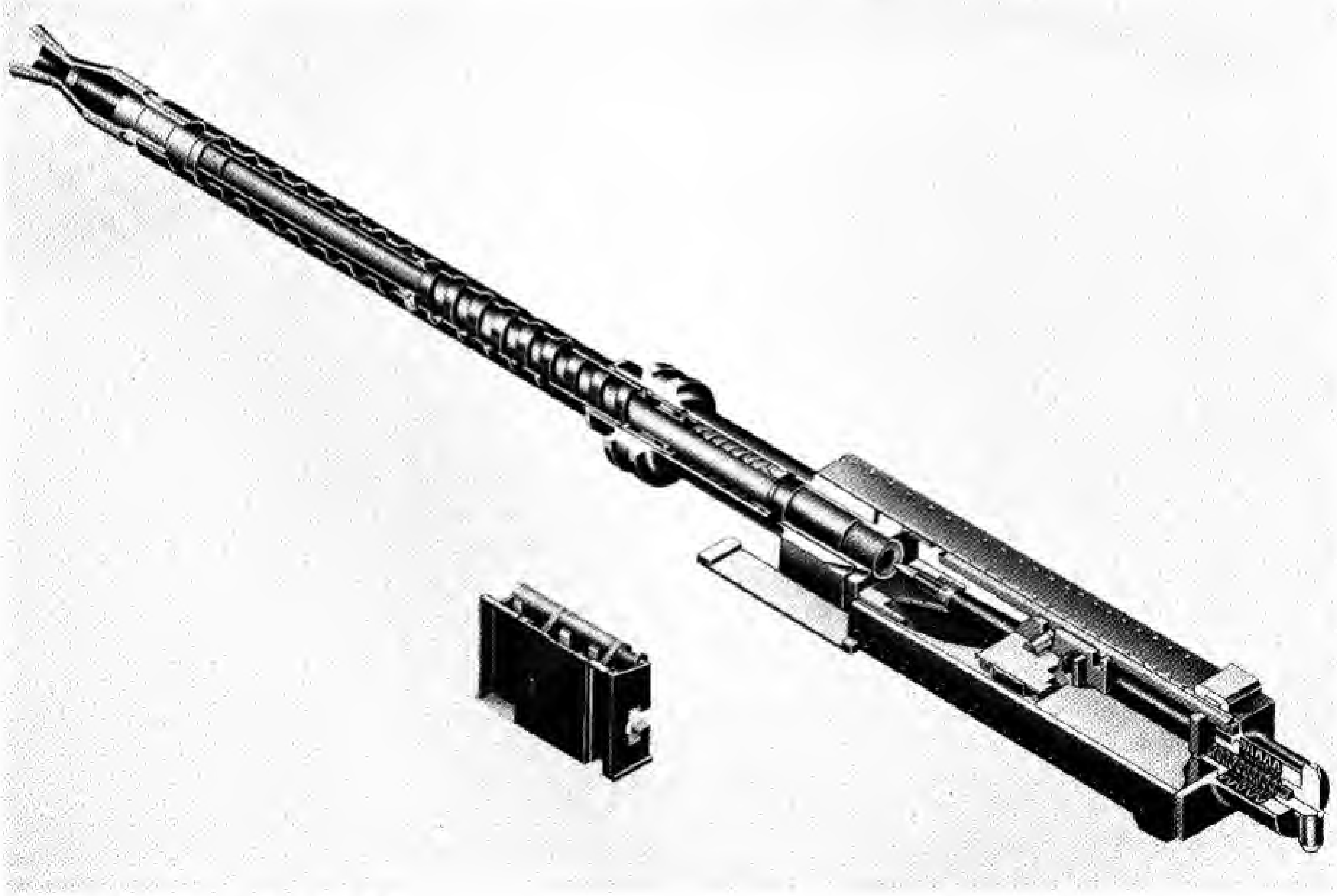
The EX-6 was a combination of proven designs which, to a large extent, resulted from "**The Machine Gun**" publications. Its features included:

(a) Receiver-German Model
(b) Round Control-Russian Model
(c) Round Index-Browning Calibre 50
(d) Link-Browning Calibre 50
(e) Locking-Modified German MG42.
(f) Feeding-Modified German MG42.

At the start of the renewal project in 1967, the only EX-6 components available to NOSL were the receiver, bolt, barrel, and barrel extension. Some sketches were available but no recorded test data. The only component which could be utilized was the receiver since the EX-6 fired the M90 series 20mm series percussion primed ammo which has a muzzle velocity of approximately 2700 fps. NOSL was to produce a gun capable of firing the Mk 100 series 20mm electric primed ammo and the XM639, WECOM 30mm percussion primed ammo.

Amazingly, however, in November 1967, NOSL started testing the gun now called the Mk 22, in the 20mm version, and in February 1968 the 30mm version. It was officially known as the Mk 22 20/30mm. There appeared to be no fault in the basic design of the weapon's past internal size restrictons of the receiver bolt. The barrel extension proved marginal for the higher chamber pressure of the Mk 100 series ammunition.

In June 1968 redesign was started to increase the



Cutaway View of Mk 22 Machine Gun

strength of the bolt and the barrel extension and also improve the gun for production purposes. At that time the M50 series round was decided upon as the Tri-service 20mm round.

On 24 July 1968, the original funding had been expended and work ceased on the Mk 22.

In November 1968, funding resumed for adapting the Mk 22 to fire the 30mm round, thus becoming the Mk 22 20/30mm.

By May 1969 three new prototypes had been made and test fired.

The rest of the history of the Mk 22 is embodied in the testing of the weapon. That is further detailed in the section entitled **Test Results.**

Description and Purpose

The Mk 22 20mm machine gun was designed to meet the requirements of the U.S. Navy in the Vietnam War, for a modern single barrel 20mm gun. The primary use was to be patrol boat armament.

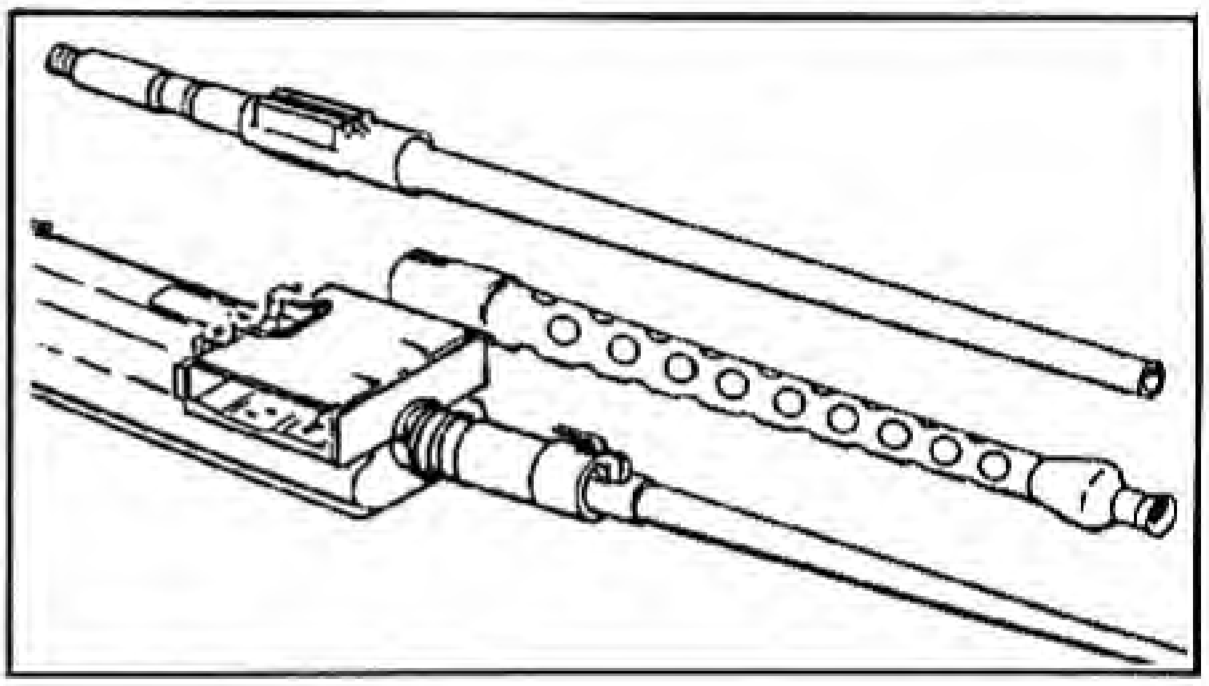
Characteristics

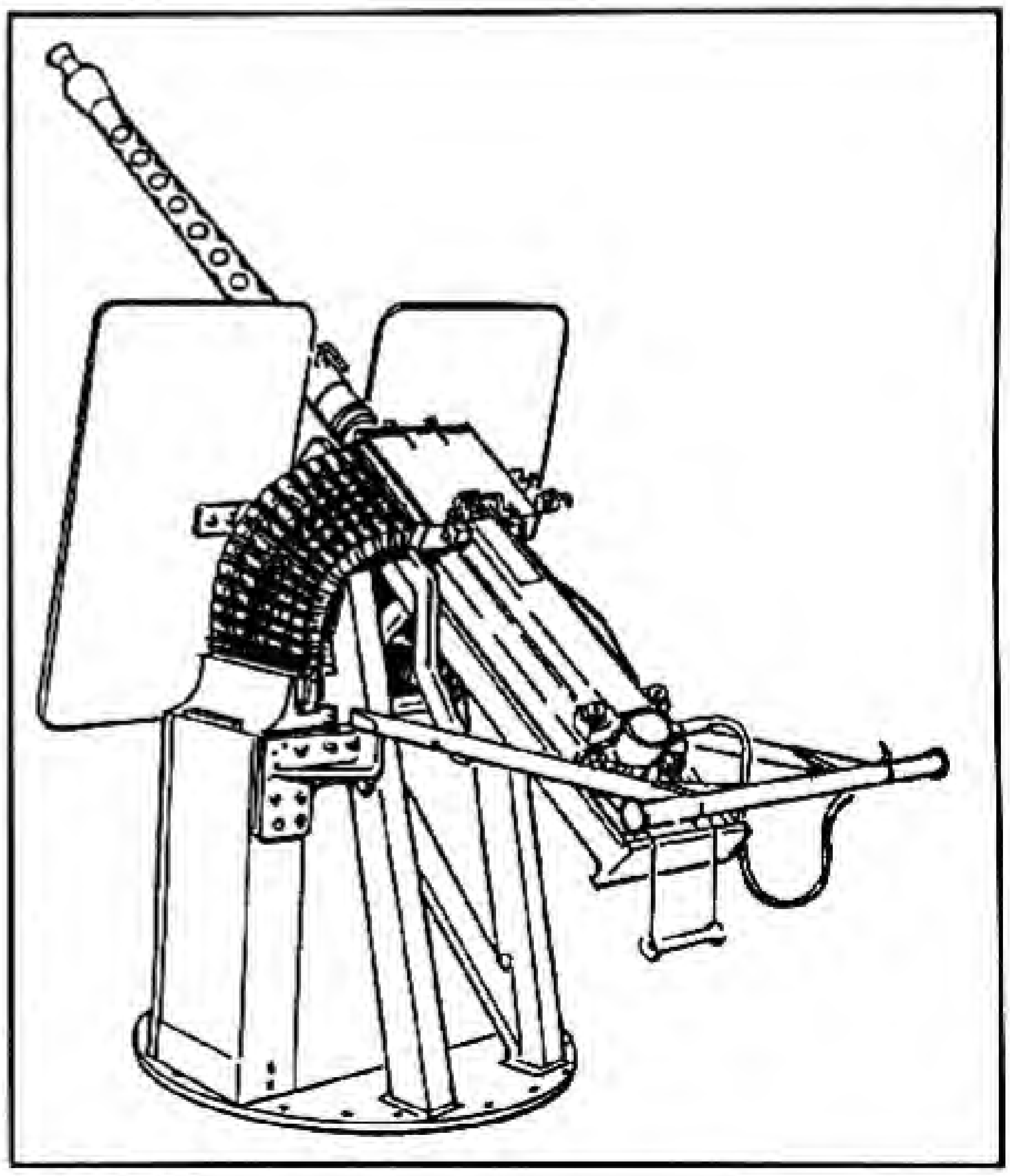
	20mm	30mm
Weight	120 lbs.	120 lbs.
Length	78¾ in.	75¼ in.
Width	7½ in.	7½ in.
Width with feeder	10 in.	10 in.
Height	7¾ in.	7¾ in.
Mode of Fire	Full or semi-automatic	Full or semi-automatic
Rate of Fire	400 to 800 rpm	350 to 750 rpm
Maximum Range	8,000 m	4,500 m
Effective Range	3,500 m	3,000 m
Muzzle Velocity	3,300 fps	2,200 fps
Barrel Length	52 in.	48½ in.
Barrel Twist	Right hand; progressive	Right hand; progressive
Cooling	Air	Air
Type of Feed	Link belt	Link belt
Direction of Feed	Left or right hand	Left or right hand
Firing Cycle	Open bolt	Open bolt
Method of Operation	Short recoil	Short recoil
Method of Fire	Electric or percussion	Electric or percussion
Method of Charging	Manual, pneumatic, or hydraulic	Manual, pneumatic, or hydraulic

The gun is an air cooled, short recoil operated, single barrel 20mm weapon firing M50 series ammunition in a disintegrating metallic link belt. The Mk 22 can fire either semi-automatic or full automatic. The natural rate of fire is 450 rounds per minute which can be increased to 850 rpm with a muzzle booster. The feed direction can be either left hand or right hand depending only upon assembly. That is, no extra parts are required.

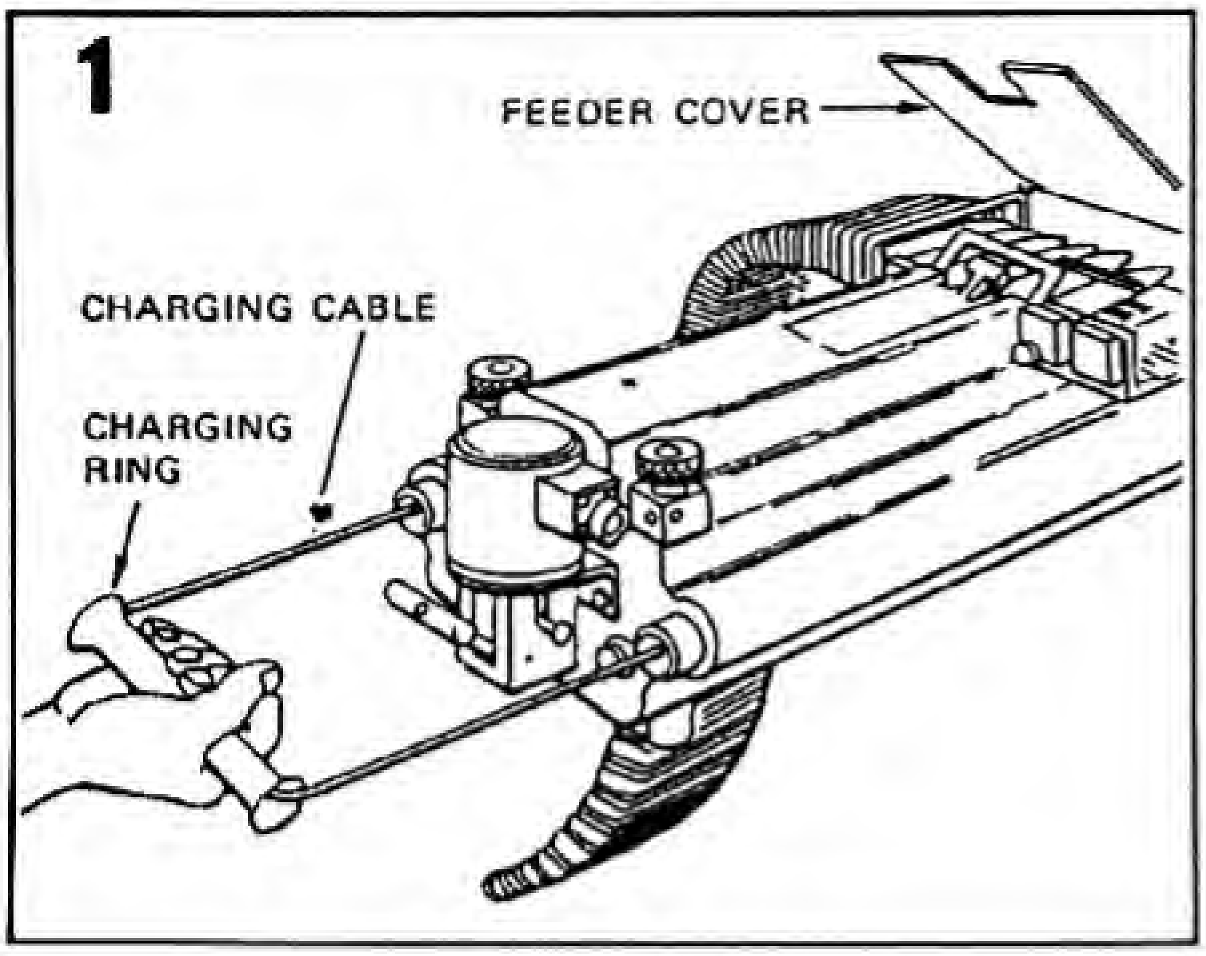
Conversion from 20mm to 30mm

The Mk 22 Machine Gun is designed for conversion from 20mm to 30mm ammunition use by simply exchanging barrel, barrel extension, feeder, and bolt.





Gun Turret



Operational Description

Loading.

1. The charging ring is pulled rearward until the bolt is seared, and the feeder cover is raised.

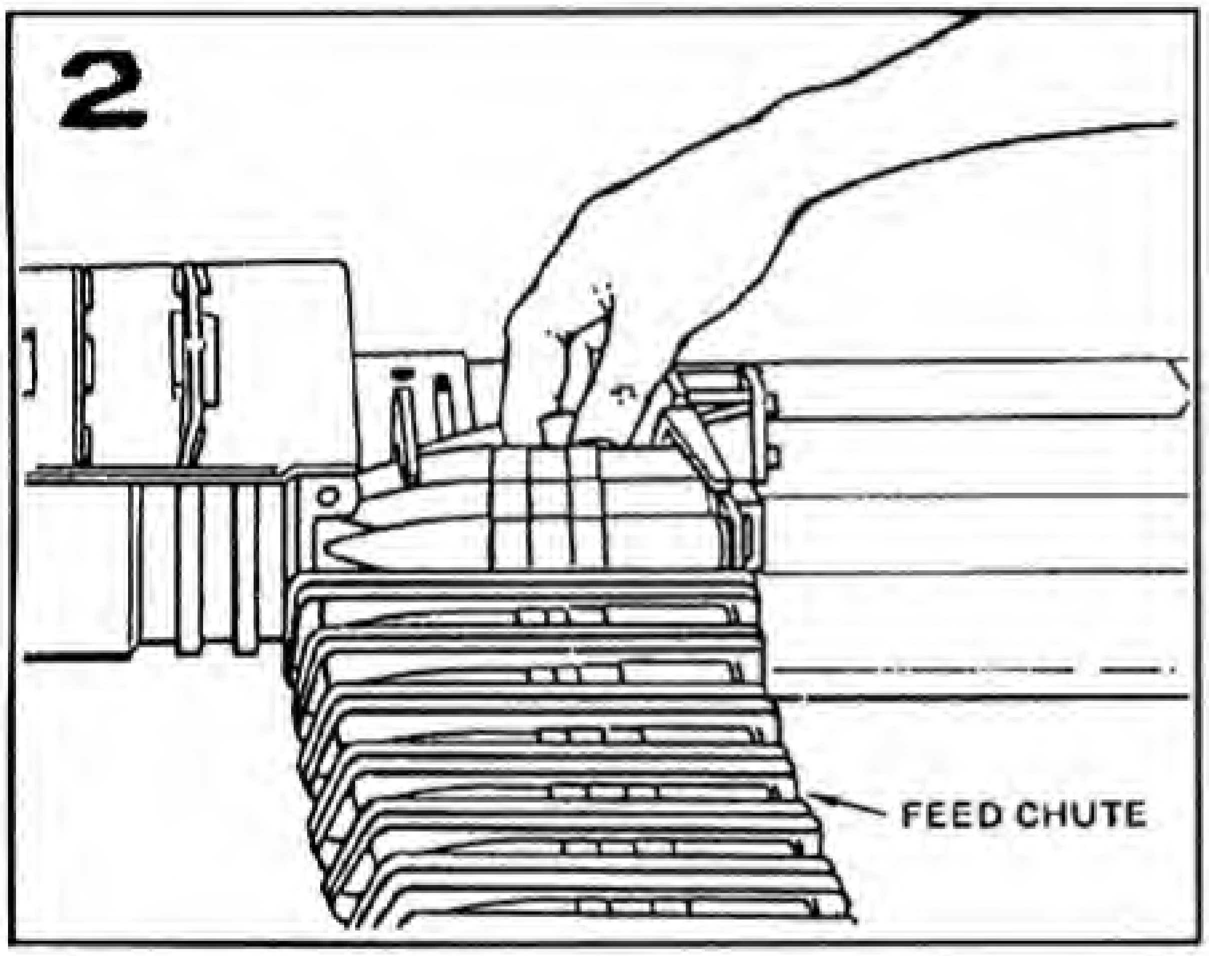
2. Linked ammunition is transferred through the feed chute from the ammunition can to the entrance of the gun feeder via a flexible ammunition belt.

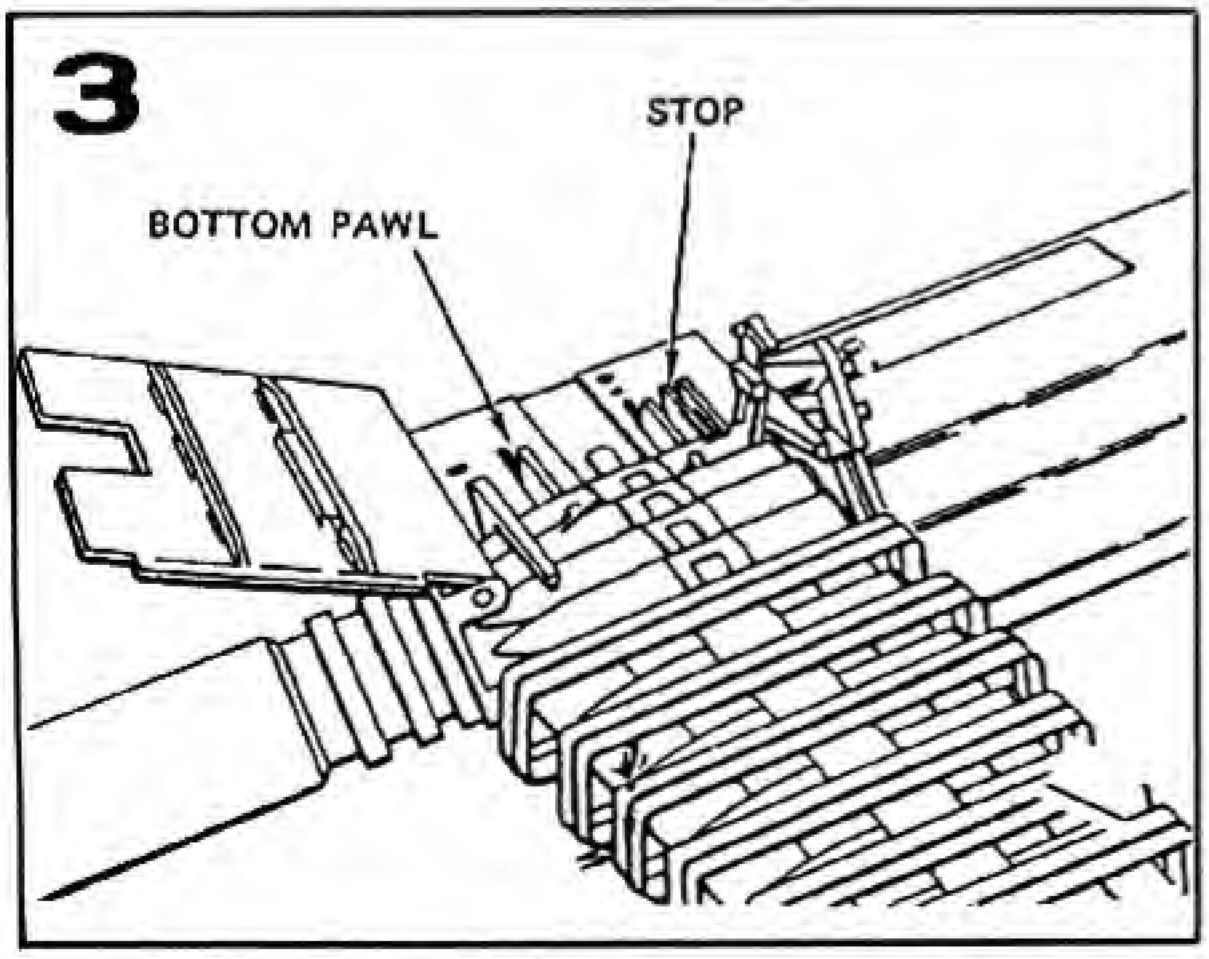
3. The ammo is fed through the gun feeder section until the first round is seated against the stops and the bottom pawls are in the up position. The sear is released, and the bolt moves forward until pickup extractors are engaged with the cartridge rim. The charging ring is again pulled rearward, until the sear is re-engaged. The gun is now ready to fire.

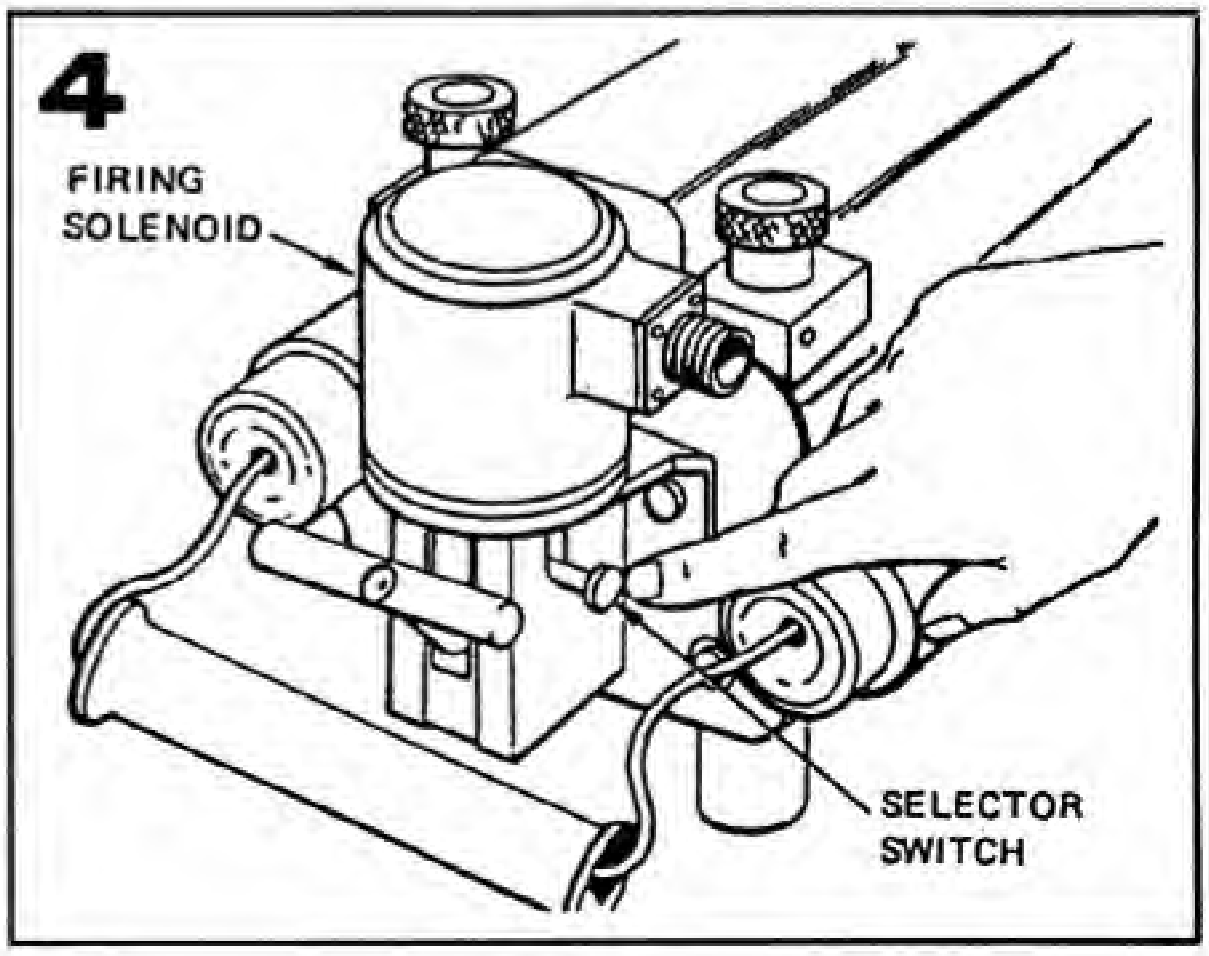
Firing.

4. A selector switch is moved from the safety position to either the semi- or fully-automatic position. If manually operated, the hands are placed on the handle bars of the mount and the gun is aimed. To fire, the firing lever is squeezed. Pressure is maintained for the length of automatic burst desired.

Operation of a remote firing switch for solenoid firing is similar to that of the firing lever.

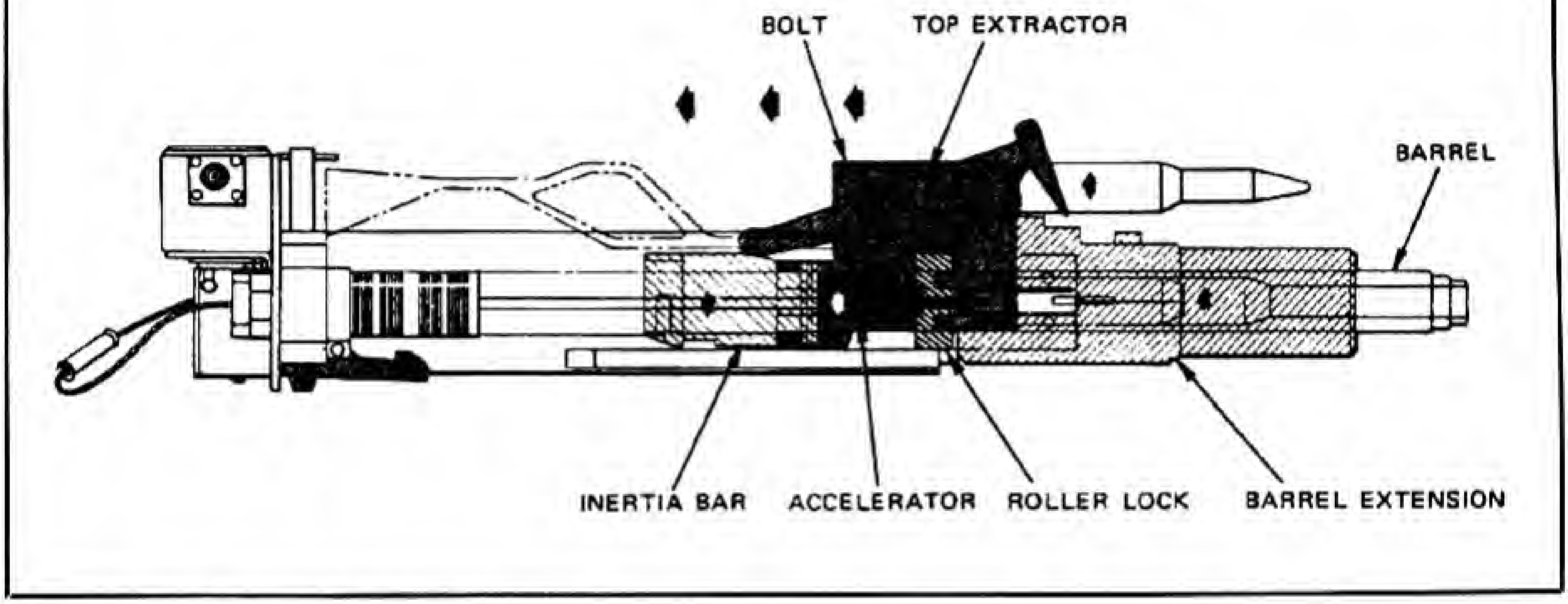






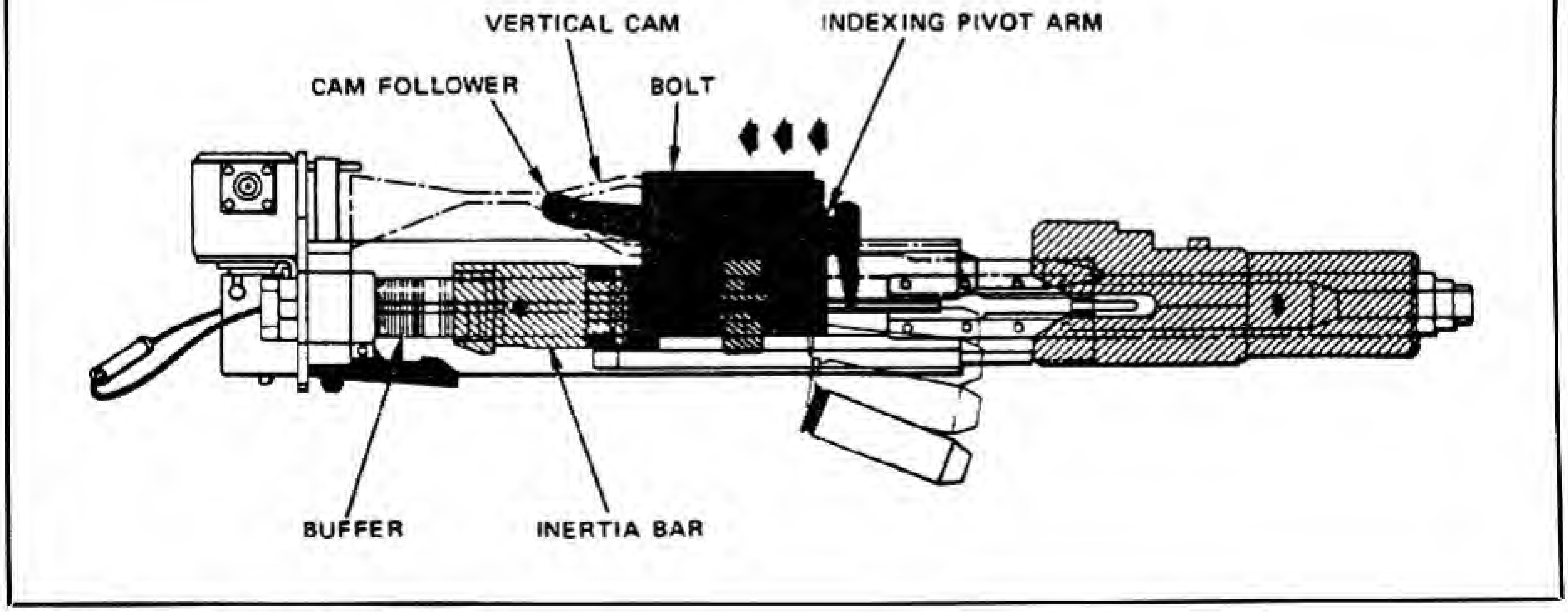
Cycle of Operation

Rearward Travel of Bolt. The recoil force from a fired round drives the bolt and inertia bar, which are securely locked to the barrel and barrel extension, toward the rear. The next round, having been connected to the bolt by the top extractors, is stripped from the link and starts rearward with the bolt. After approximately 7/8-in of travel, the roller locks are cammed inward, forcing the accelerator and thereby the inertia bar rearward, unlocking the bolt and inertia bar from the barrel and barrel extension. The barrel and barrel extension then reverse direction and are driven forward to battery position by the barrel recoil spring, damped by the ring springs.


BOLT
TOP EXTRACTOR
BARREL
INERTIA BAR
ACCELERATOR
ROLLER LOCK
BARREL EXTENSION

Battery Position Picking up Round

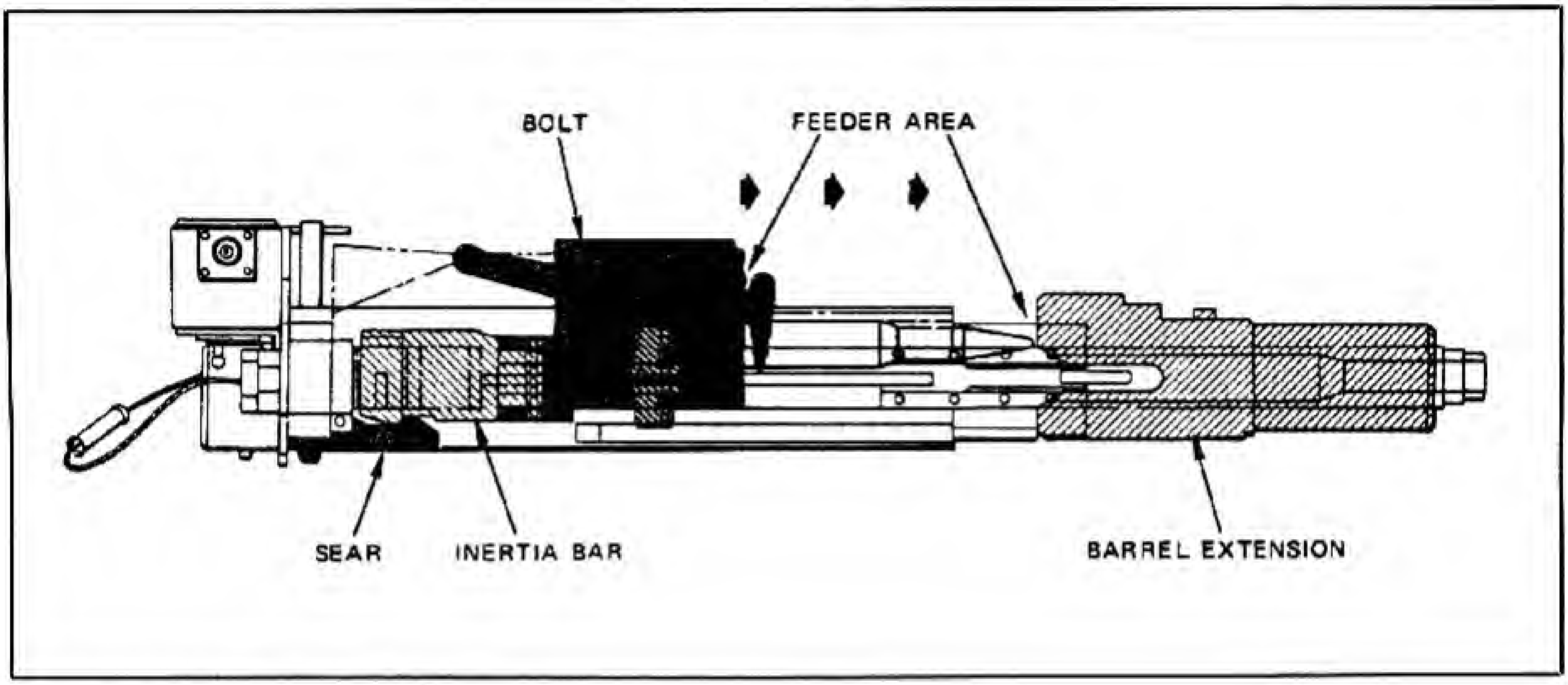
The bolt travels approximately five inches to the rear before the vertical cam engages the cam follower and begins to move the indexing pivot arm around its pivot point. As the bolt and inertia bar continue rearward, the incoming round is indexed down the bolt face by the cammed action of the pivot arm, forcing the empty case of the previous round from the weapon.


VERTICAL CAM
INDEXING PIVOT ARM
CAM FOLLOWER
BOLT
BUFFER
INERTIA BAR

Recoil Position Ejecting Fired Case

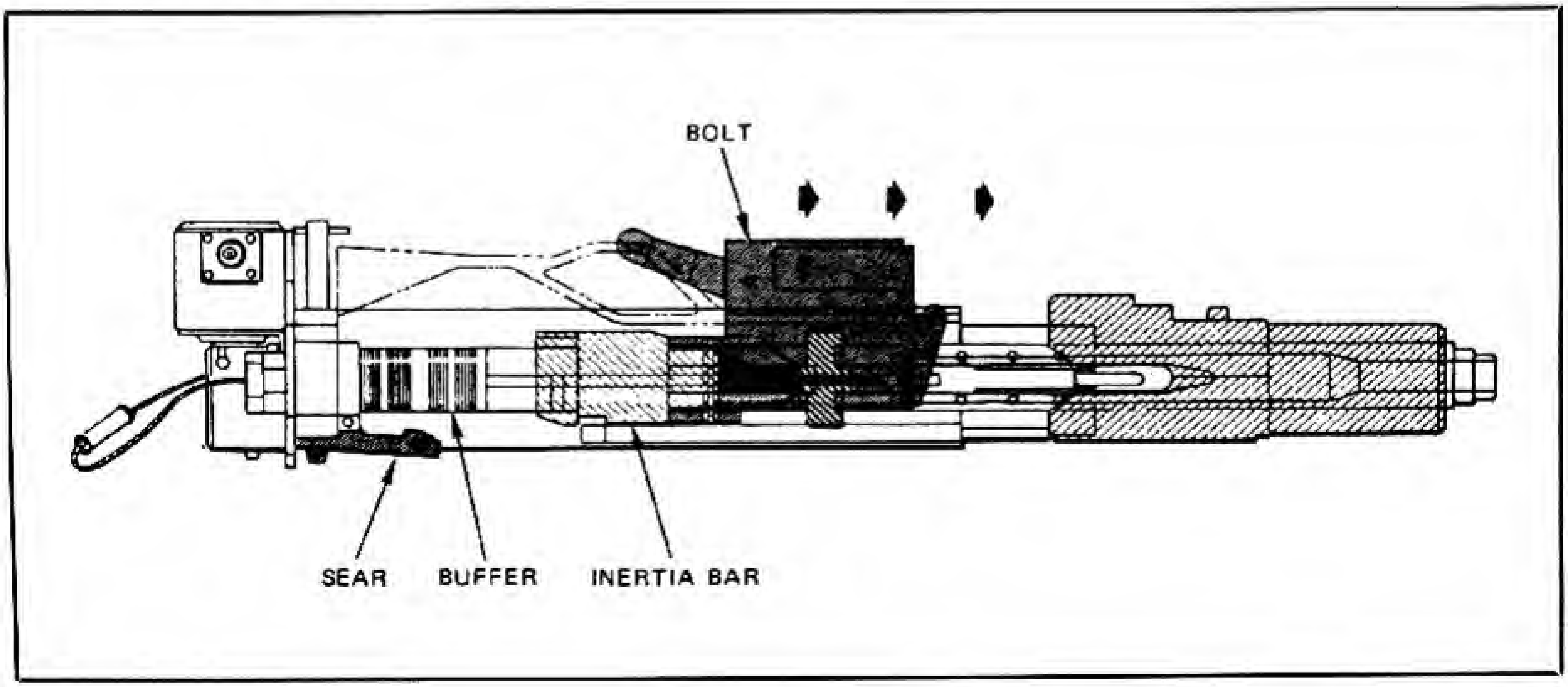
The inertia bar, with the bolt, continues to the rear until it hits the buffer and reverses direction. It is engaged by the sear and is prevented from going forward unless in the automatic firing mode.

The recoil of the barrel extension drives a feeder shuttle over into position behind the next round and compresses a feeder drive spring. As the round is pulled out of the feeder by the bolt, a feeder cam, which is driven by the feeder drive spring, moves the feeder shuttle and the next round into position for extraction by the bolt. The reusable link is discharged to the side.

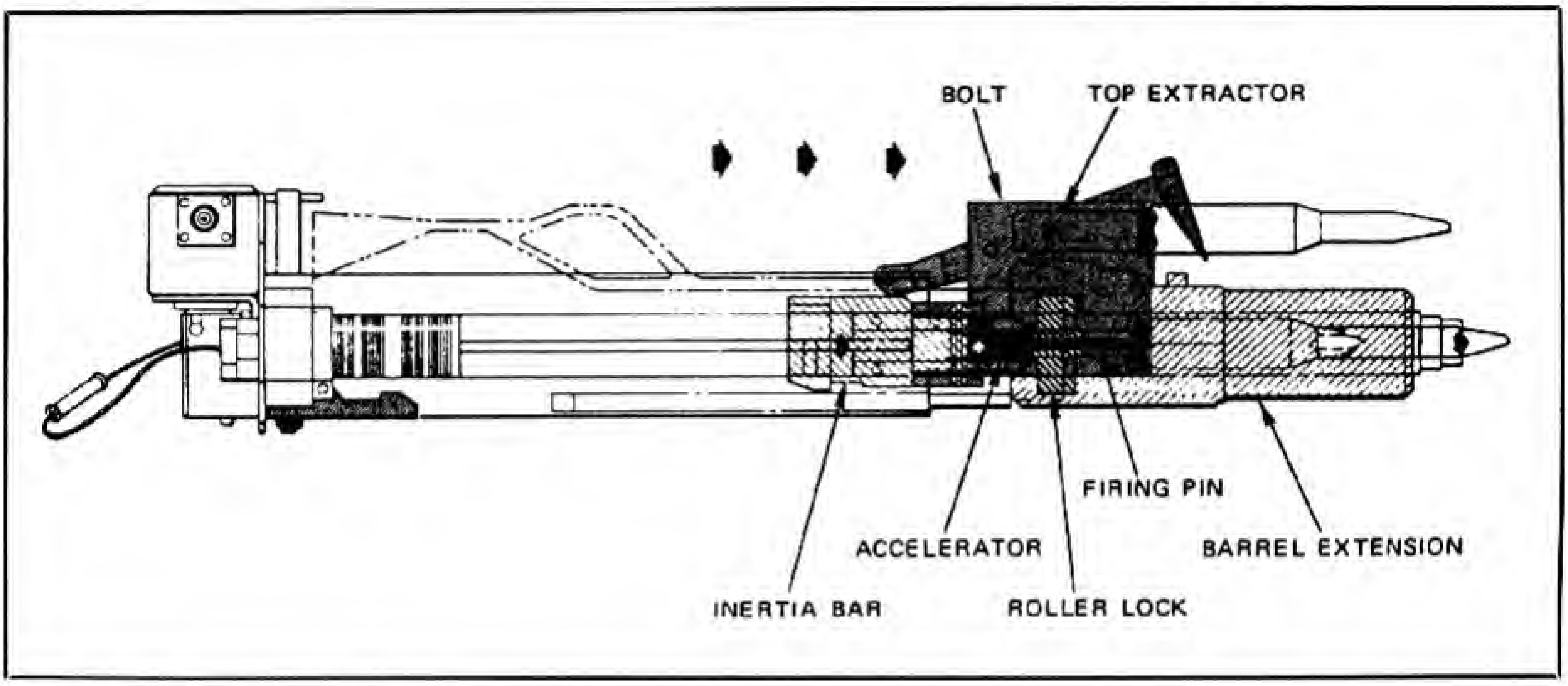


Counterrecoil Movement

Forward Travel of Bolt. When the sear is released, either manually or electrically, or remains released for automatic fire, the bolt and inertia bar are pushed forward by the driving springs.



As the bolt continues into battery position, the top extractor engages the following round in the pickup position in the feeder, and the two roller locks are cammed outward into recesses in the barrel extension. When the roller locks move outward, the accelerator is driven forward by the inertia bar, driving the firing pin into the primer, and thus firing the round.



Firing Position

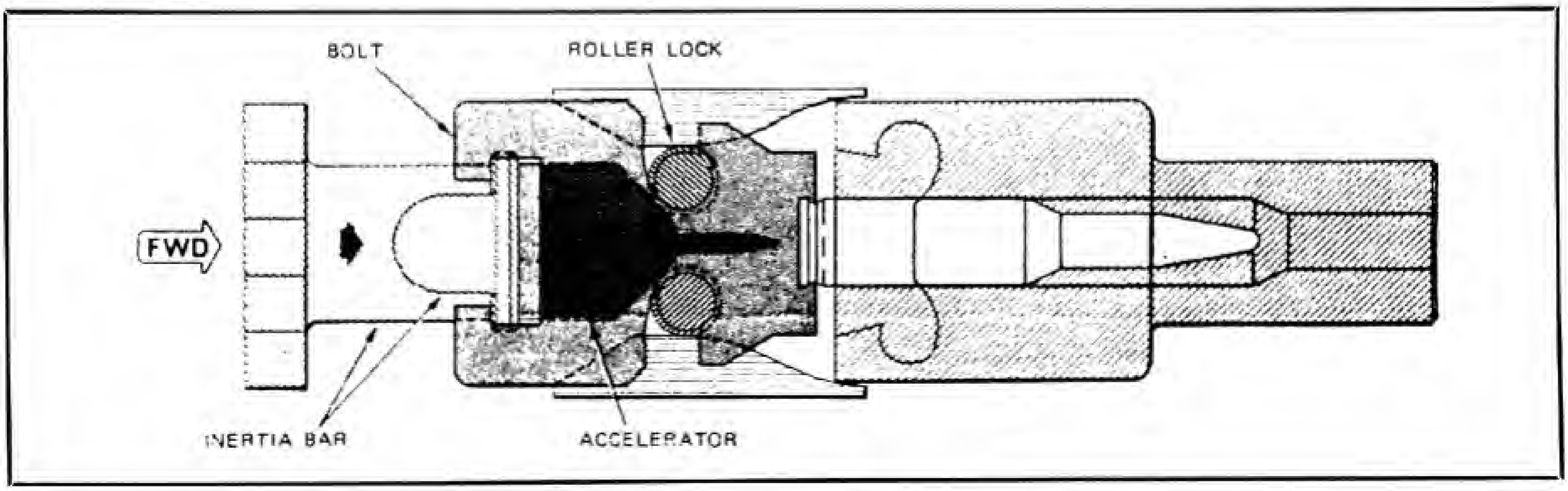
Locking Cycle. The bolt is pushed forward by drive springs, with the roller locks in their innermost position, and the accelerator and inertia bar to the most rearward position.

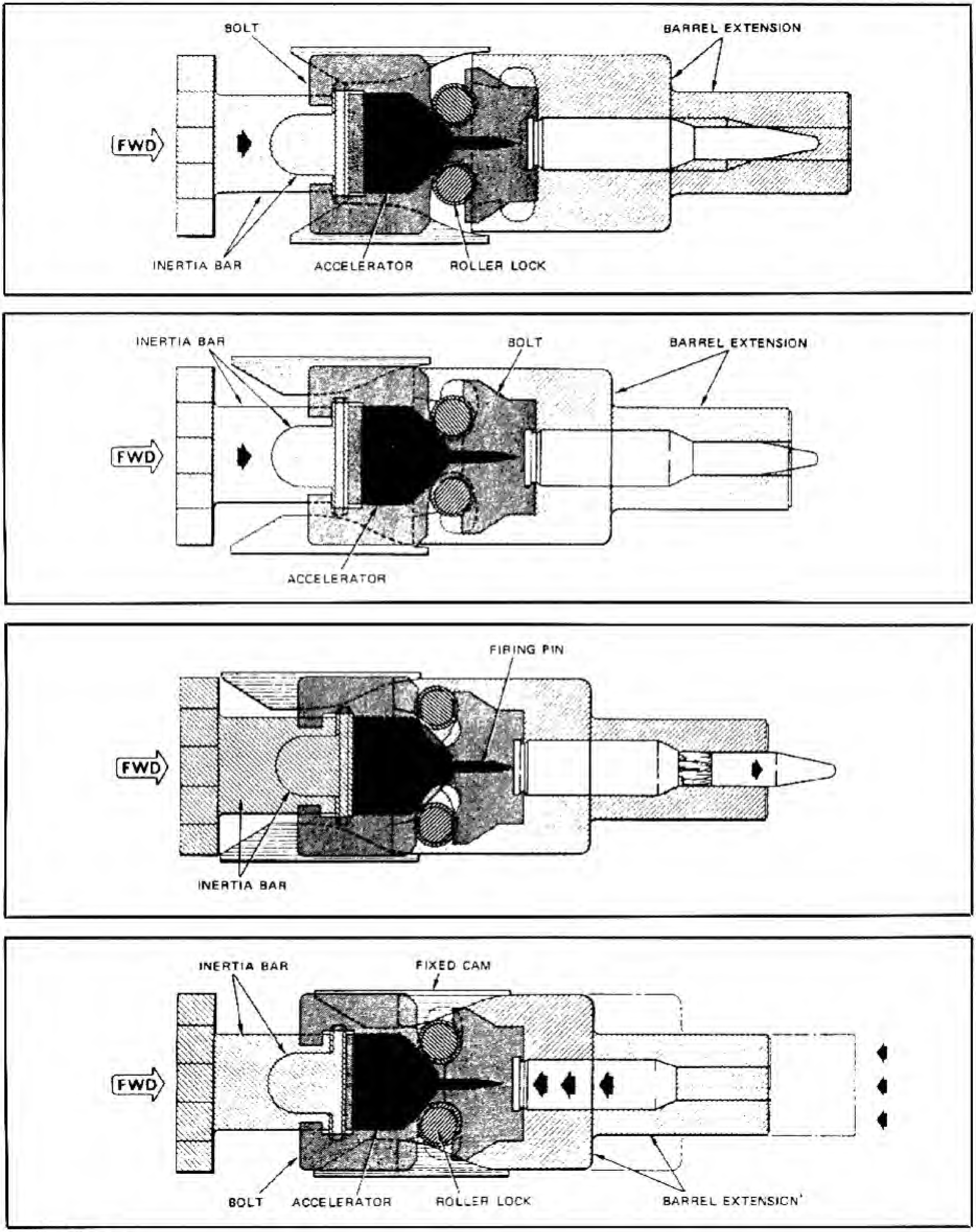
When the bolt first engages the barrel extension, the two roller locks are still in their innermost position, and the accelerator and inertia bar are still in the rearward position.

As the bolt moves farther into the barrel extension, the two roller locks move outward into the recesses of the locking area in the barrel extension, allowing the accelerator to be driven forward by the inertia bar.

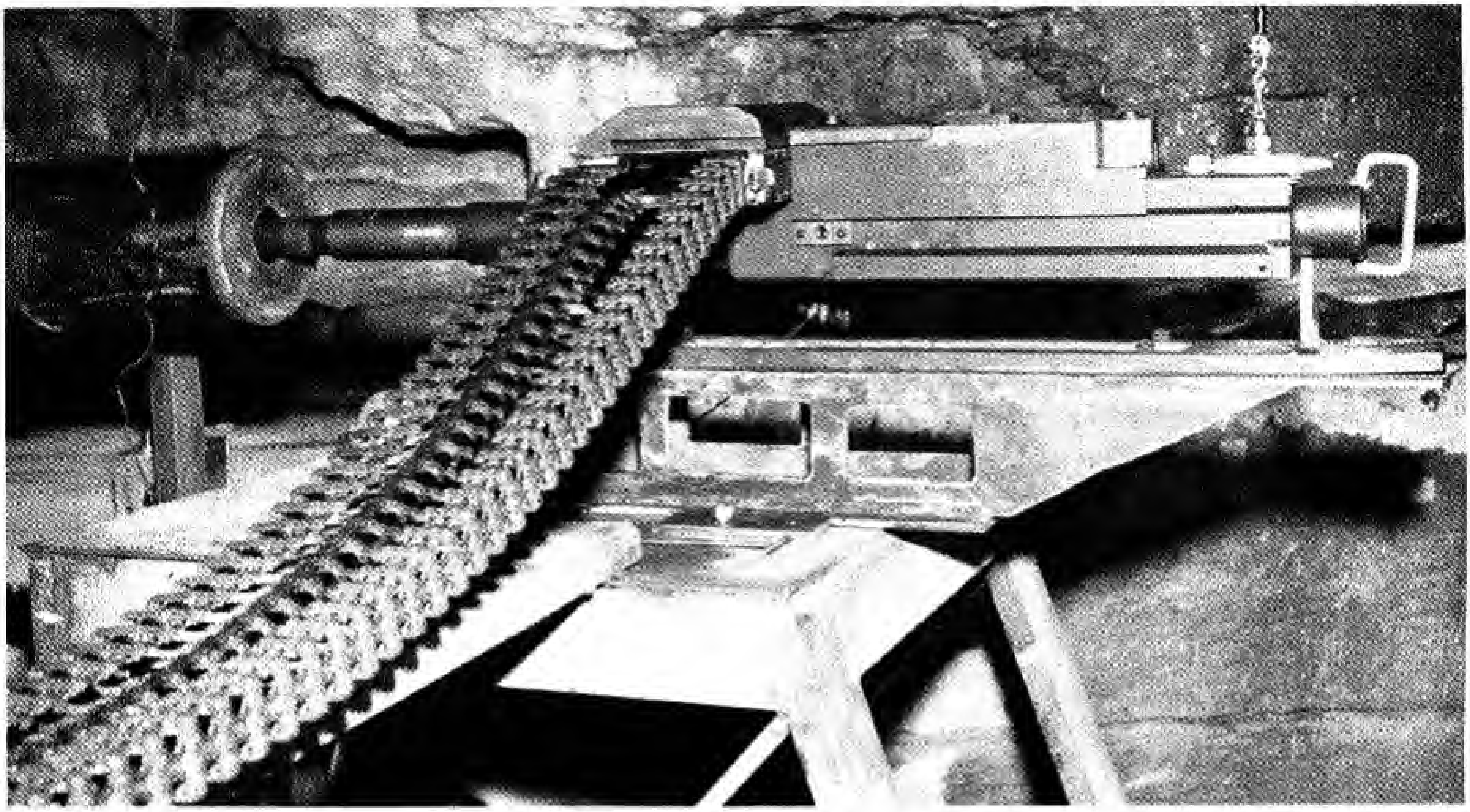
Further forward travel of the inertia bar drives the firing pin into the primer, firing the round.

The recoil force from the fired round drives the bolt and the inertia bar, which are securely locked to the barrel and barrel extension, rearward. After 7/8-inch of travel the roller locks are cammed inward by the fixed cams, forcing the accelerator and the inertia bar rearward and unlocking the bolt and inertia bar from the barrel and barrel extension.




BOLT
BARREL EXTENSION
FWD
INERTIA BAR
ACCELERATOR
ROLLER LOCK
INERTIA BAR
BOLT
BARREL EXTENSION
FWD
ACCELERATOR
FIRING PIN
FWD
INERTIA BAR
INERTIA BAR
FIXED CAM
FWD
BOLT
ACCELERATOR
ROLLER LOCK
BARREL EXTENSION

Locking System



Mk 22 Engineering Prototype

Test Results

The 20mm Mk 22 Mod 0 was first tested in November 1967 at NOSL firing Mk 100 series ammunition. A 30mm version firing XM639 ammunition was fired in February 1968. These tests demonstrated the basic soundness of the weapon design. However, size restrictions made the weapon marginal for the Mk 100 ammunition.

Using 20mm M50 series ammunition three newly built Mk 22 guns had fired over 13,000 rounds at Louisville by May 1969. Two of the guns were then tested at NWLD and out of 2100 rounds fired there were 130 malfunctions for a mean round between stoppages of 16. The immediate cause was determined to be that a hard mount was used by NWLD while a soft mount had been used at NOSL. It was determined at Louisville that, using a rigid mount, the receiver would sometimes flex to the point where the bolt would not unlock.

A redesign of the receiver and feeder followed and further testing showed that while the flexing of the receiver had been eliminated there were still difficulties with the feeder. A new feeder was designed and by May 1971, a total of 13,500 M50 series rounds had been fired. In that month the feeder was further improved so that the feeder lever operated directly off the barrel extension. A total of 28,530 rounds, including some electric primed ammunition, had been fired by the first week in August 1971.

A second series of tests began at NWLD in mid-August 1971. These tests were part of a "shoot off" between the Mk 22, the Mauser Model B, the GE 120B, and the AME 621.

In those tests, the Mk 22 fired a total of 14,500 rounds with twenty-three malfunctions which involved only eight gun components. All environmental tests were passed and problems which occurred during the tests were corrected.

As a result of the Dahlgren tests eleven design changes were made to correct the design deficiencies which accounted for all of the malfunctions.

The two test guns were modified in accordance with the design changes and were returned to NWLD in April 1972 for further test firing and safety certification.

The report on that test states that approximately 4500 rounds were fired in each of the two Mk 22 Machine Guns and no gun and ammunition compatibility problems were encountered. Measurements taken during firing indicated satisfactory ammunition performance.

A comparison of the firing records obtained for the two test weapons during this certification and records obtained during previous evaluations at NWLD indicate that the Mk 22 gun again demonstrated significant improvements in reliability and performance.

Strengthening of the EX 9 Link contributed to the weapon's improved performance. The addition of positioning guides and plungers in the feed mechanism improved round control during feeding and chambering. Material has been added to the barrel in weak spots and one gun successfully completed a 400 round continuous burst on the second attempt during the certification. Other problems noted in previous evaluations were eliminated.

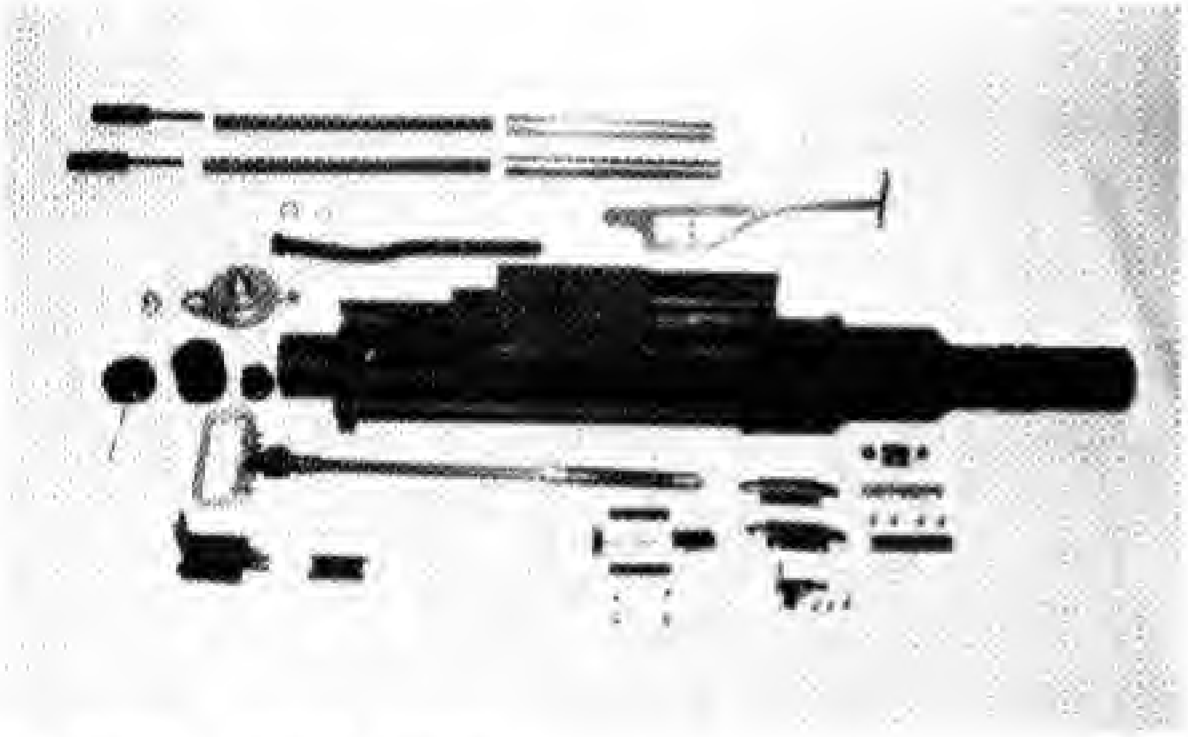
A total of 9128 rounds was fired from the two Mk 22 test guns during the certification and the MRBS was 1304 rounds for the two guns combined.

All stoppages experienced were cleared quickly and safely and no unsafe situation occurred during any of the firing.

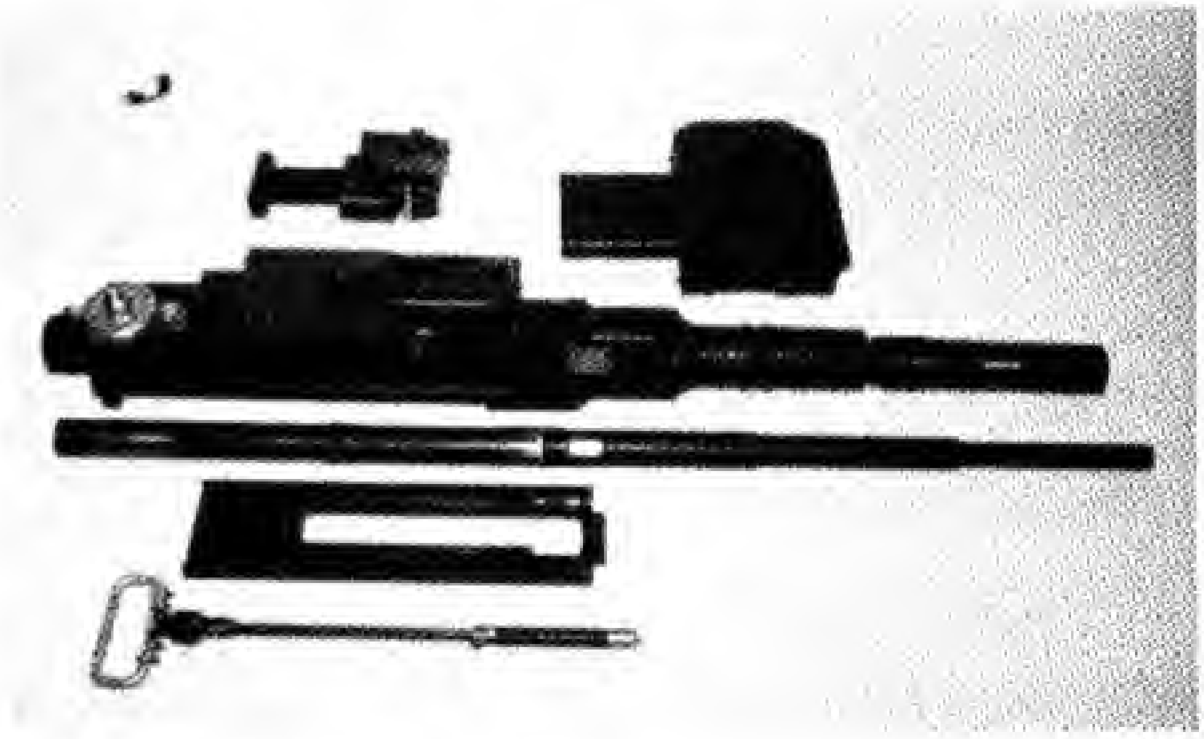
AMMUNITION

20mm	*30mm*
HPT M54	TP XM639
TP M55	
HEI M56A3	

20mm and 30mm Ammunition



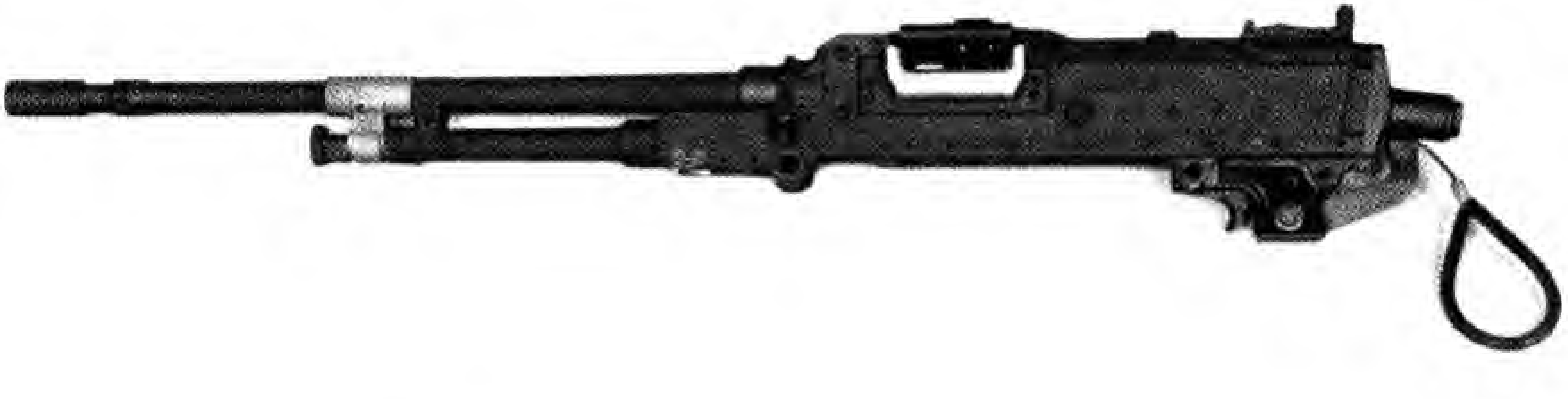
Exploded View of Mk 22



Major Components

Chapter 21

7.62mm MAG-58 M240 AUTOMATIC WEAPON
FABRIQUE NATIONALE



7.62mm MAG-58 M240 Machine Gun

History

In 1958, during the Korean War, Fabrique Nationale developed a reliable, versatile family of automatic weapons, among them a GPMG (General Purpose Machine Gun) now known as the MAG-58 and chambered for the then newly introduced 7.62 x 51mm NATO cartridge.

The MAG-58 is currently employed by the armed forces of ninety countries, including the U.S. In 1978 the Army, with its new M1 main battle tank still in the development stage, saw the need for a high performance, coaxial tank machine gun and found that the MAG-58 met the requirements after slight modifications.

In September 1979 Fabrique Nationale, Herstal, was awarded a U.S. contract to produce 16,417 MAG-58 coaxial machine guns over a five-year period. The MAG-58 was redesignated the M240 by the Army which has since procured an additional 2,700 under a stipulated initial contract option.

Additionally, the M240 is employed with the M48 and M60A3 tanks, the M2 and M3 IFV's (Infantry Fighting Vehicles), and the Marine Corps' LAV (Light Amphibious Vehicle) as well as other NATO alliance armored vehicles.

After winning the contract in 1979, to produce the M240 Machine Gun (the U.S. Army version of the MAG-58), Fabrique Nationale completed production of the initial 10,000 weapons.

As of October 1986, Fabrique Nationale has produced a total of 22,775 M240 Machine Guns at the Columbia Factory.

General Description

The General Purpose Machine Gun, known as the MAG-58, is the most reliable and one of the most versatile weapons in the world. "M.A.G." stands for Mitrailleuse a' gaz. The U.S. Army found it to be the

Characteristics

Bore Size	7.62mm
Muzzle Velocity	2690 fps
Rate of Fire	650/1000 rpm
Basic System of Operation	Gas
Locking System	Propped Lock
Power Source Feed System	Recoil
Feed System	Lever Type
Type of Feed (Location)	Link
Method of Chambering	Ram
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	Foreign
Developer	Fabrique Nationale
Mean Rounds Between Failure (MRBF)	26,000 rounds
Ammunition:	
Type	7.62 x 51 NATO
Performance Data	Practical Range 1000 M
Gun Size:	
Length	49.4 in.
Width	5.4 in.
Height	6.3 in.
Weight	24.2 lbs.
Barrel Dimensions:	
Length	22.4 in.
Weight	6.6 lbs.
Barrel Removal	Quick Change
Number of Grooves	4
Twist	Right Hand
Type of Firing Mechanism	Percussion
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Manual

ideal co-axial weapon for the M1 Main Battle Tank (Abrams), as well as an excellent support weapon on infantry and cavalry (Bradley) fighting vehicles. It provides a light weight, air cooled, link belt fed, gas operated, fixed headspace and timing and open bolt machine gun normally fired from its bipod, but can also be mounted on a tripod.

The air-cooled barrel is highly resistant thanks to the chromium plating of the bore and can be changed in a few seconds under battle conditions.

Propellant gas is used to operate a breech mechanism with a toggle-activated locking lever under the bolt.

The machine gunner's safety is totally guaranteed since the firing pin is an integral part of the slide and cannot operate prior to complete locking of the mechanism. Furthermore, any incident due to cook-off, unfortunately all too common with other systems, is prevented by the open breech firing which ensures that no cartridge is in the chamber after firing. Experienced users of the G.P.M.G. consider its most important features to be:

—total reliability and ruggedness that can ignore both the violent impact experienced in armoured vehicles and adverse conditions such as mud, rain, snow, sand and extreme temperatures;

—simplicity in firing and in field maintenance;

—flexible operation due to the adjustable firing rate;

—total reliability when fixed on rigid or soft mount;

—good sealing of its mechanism.

The gun's action is similar to the Browning Automatic Rifle (BAR) and incorporates the universally proven Browning durability, reliability and quality. Combined government and contractor testing has produced a 26,000 mean round between failure (MRBF) score over a half million rounds fired. The M240 is easily adapted to other vehicle/platforms and ground firing modes that are totally interoperable (RSI) with the FN MAG-58.

Cycle of Operation

The MAG-58 is gas operated. The firing cycle commences when the slide and bolt are caught to the rear by the sear, cartridges are in the feed tray, and the trigger is pressed.

When the trigger is pressed, the sear releases the slide. The slide, under the force of the driving spring, starts forward; the bolt, attached to the slide, moves with it. The feed rib drives the cartridge out of the feed tray and into the chamber.

The curved area of the lock contacts the cams on the bolt guide and starts to move down. The bolt continuing forward chambers the round and the extractor snaps into the cartridge case groove. As the bolt lock moves down, the link pin moves past the center line of the other two pins and this causes the link to rotate down and seat the lock against the shoulder in the receiver.

The slide continues forward and the firing pin, mounted in the slide, finally strikes the primer and fires the cartridge. Forward motion ceases when the slide strikes the gas cylinder tube.

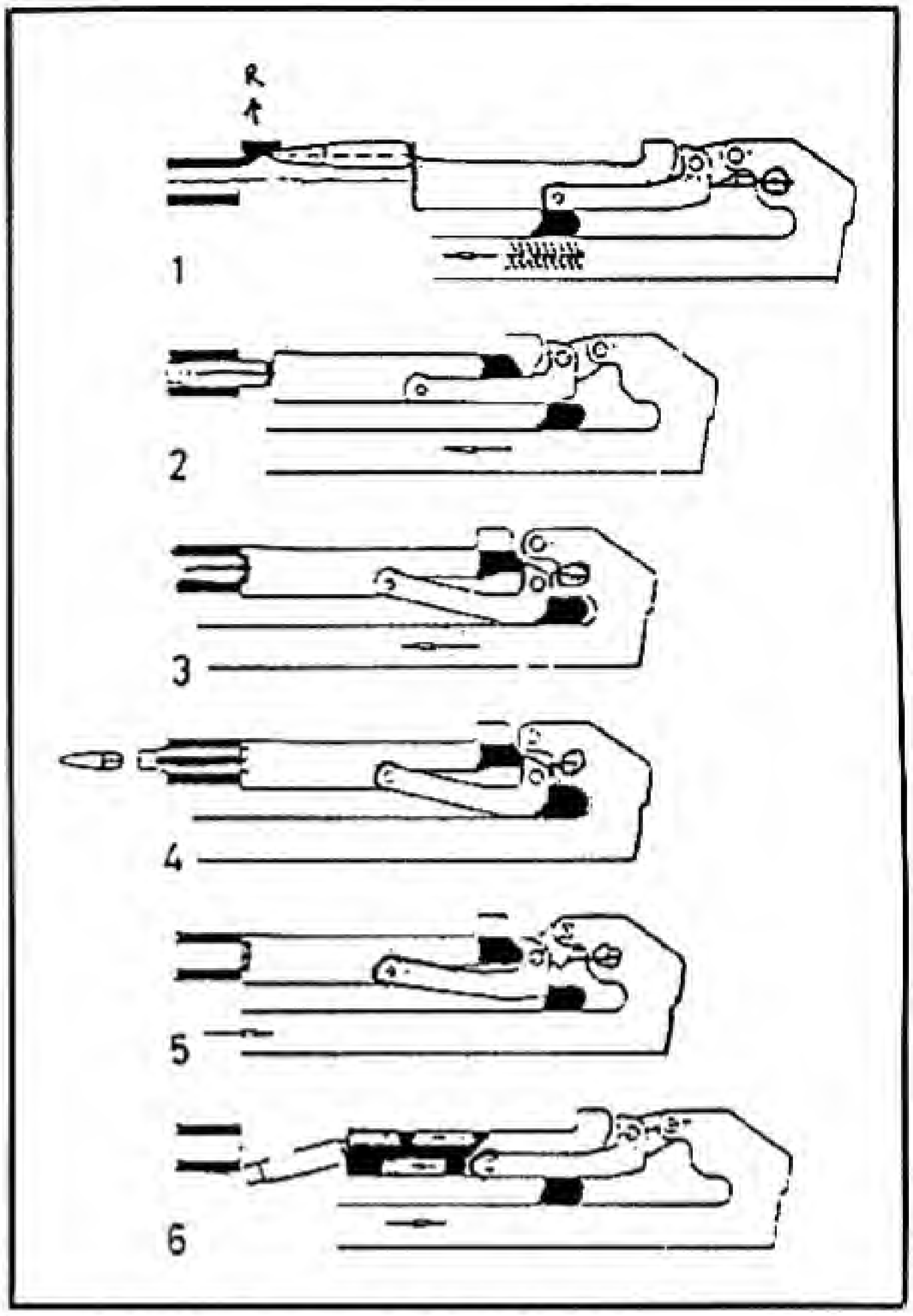
The propellant gases, vented into the gas cylinder after the bullet passes the gas port, drive the piston and slide rearward. This action compresses the driving spring, and, upon first motion of the slide, retracts the firing pin into the bolt. The link rotates upward and pulls the lock out of engagement with the shoulder in the receiver. As the lock moves up, the curved surfaces bear against the bolt which "cracks" the cartridge loose from the chamber. This slow initial extraction contributes greatly to the M.A.G.'s reliability.

As the slide continues rearward, the lock is completely withdrawn from the locking shoulder and finally it and the bolt travel rearward with the slide. The extractor holds the cartridge case to the bolt face until the case clears the chamber. The ejector spring then expands and the ejector expels the case from the bottom of the weapon. Rearward motion ceases when the slide strikes the buffer.

The trigger mechanism is very simple. When the trigger is pressed, it pivots on a pin and the roller lifts the front of the sear. The sear pivots on its pin and releases the slide. As the sear rises, the T lug is caught by the notch of the sear catch. When the trigger is released, it rotates about its pin and the sear catch moves upward. This action further elevates the front end of the sear. As the sear catch rises, it is hit by the recoiling bolt and rocked rearward, releasing the sear. The sear, under pressure of its spring, rises and catches the slide when it counterrecoils. The slow rising of the sear with resultant partial engagement of the sear and slide prevents battering and breakage.

The safety is a bar with a cutaway section. When the cutaway section is under the sear, the trigger, when pressed, causes the sear to depress and the cutaway provides room for the sear to move. When the safety is on Safe, the cutaway is moved to one side and the solid portion of the safety moves under the sear and prevents it from depressing and releasing the slide.

The feed mechanism is actuated by the recoil and counterrecoil of the slide. A roller on the slide rides in a channel in the belt feed lever and the lever is pivoted and shaped so that the roller makes the front end of the lever move from side to side. When the slide is released by the sear and starts forward, the roller moves in a straight section of the lever and no sidewise motion occurs until the round in the feed tray is driven out of the link. At that time, the roller moves into the curved portion of the lever and the front end of the lever moves to the right. The lever causes the link to move the feed slide to the right. The pawls on the feed slide move the next cartridge inward, onto the slot on the feed tray. The cartridge guide snaps over the cartridge and holds it in the slot. When the slide is fully inward, a holding pawl snaps into place to prevent withdrawal of the round/belt. The round that had been rammed out of the feed tray fires and the slide starts to recoil.



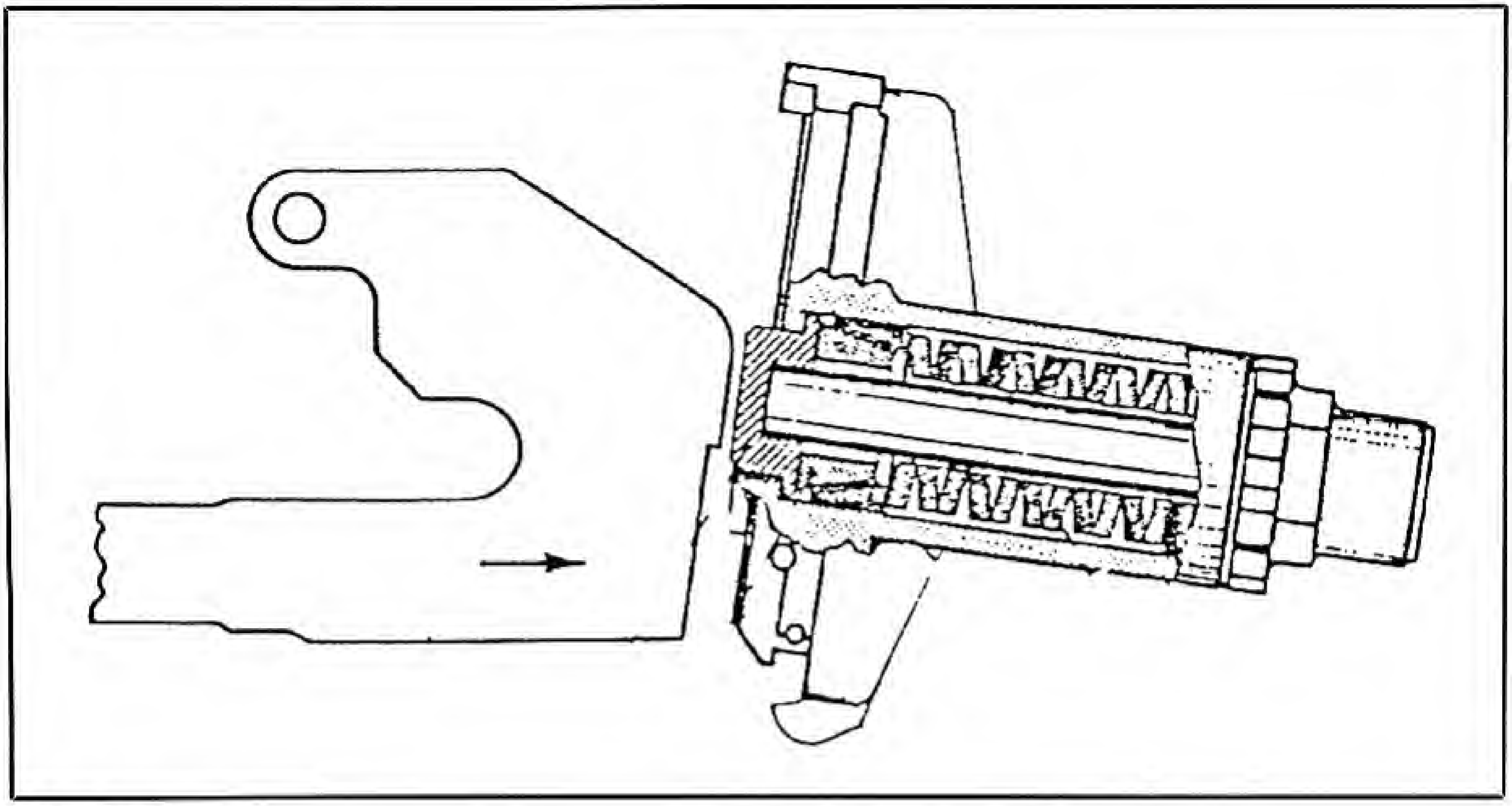
Breech Locking Sequence of the MAG-58

As the slide recoils, the roller moves the front end of the lever to the left; this causes the link to move the slide outward. The feed pawls override the cartridges held by the holding pawls and position themselves in preparation for feeding the next round.

Buffer Recoil

At the end of its backward movement, the piston extension strikes the buffer bush housed in the buffer block and forces it to recoil slightly.

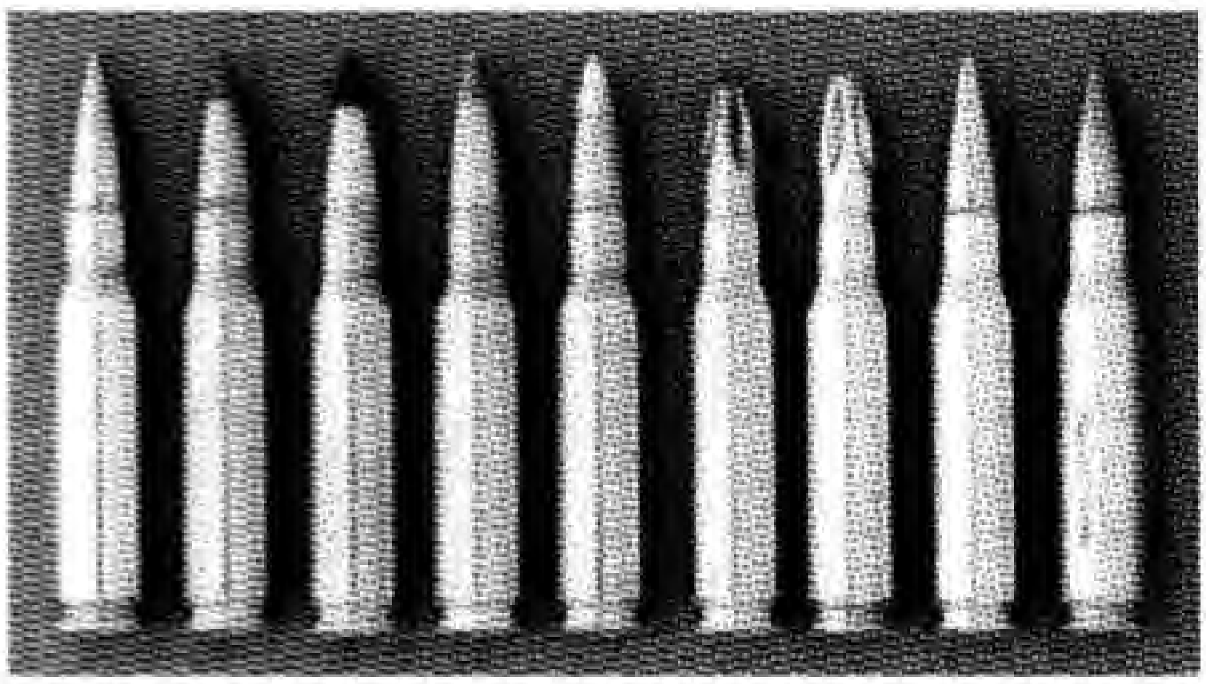
The buffer bush transfers its movement to a braking cone, which penetrates a braking ring, making it open slightly.



Buffer Recoil

As it expands, the braking ring contacts the wall of the buffer cylinder and thus exerts a braking action which, combined with the compression of the Belleville spring washers, absorbs a considerable amount of the recoil shock.

After the Belleville washers have been compressed by the recoil as the piston extension strikes the buffer plate they return to their original position under their spring effect and again push forward the braking ring, the cone and the buffer bush, thus restoring the whole assembly to its former position.

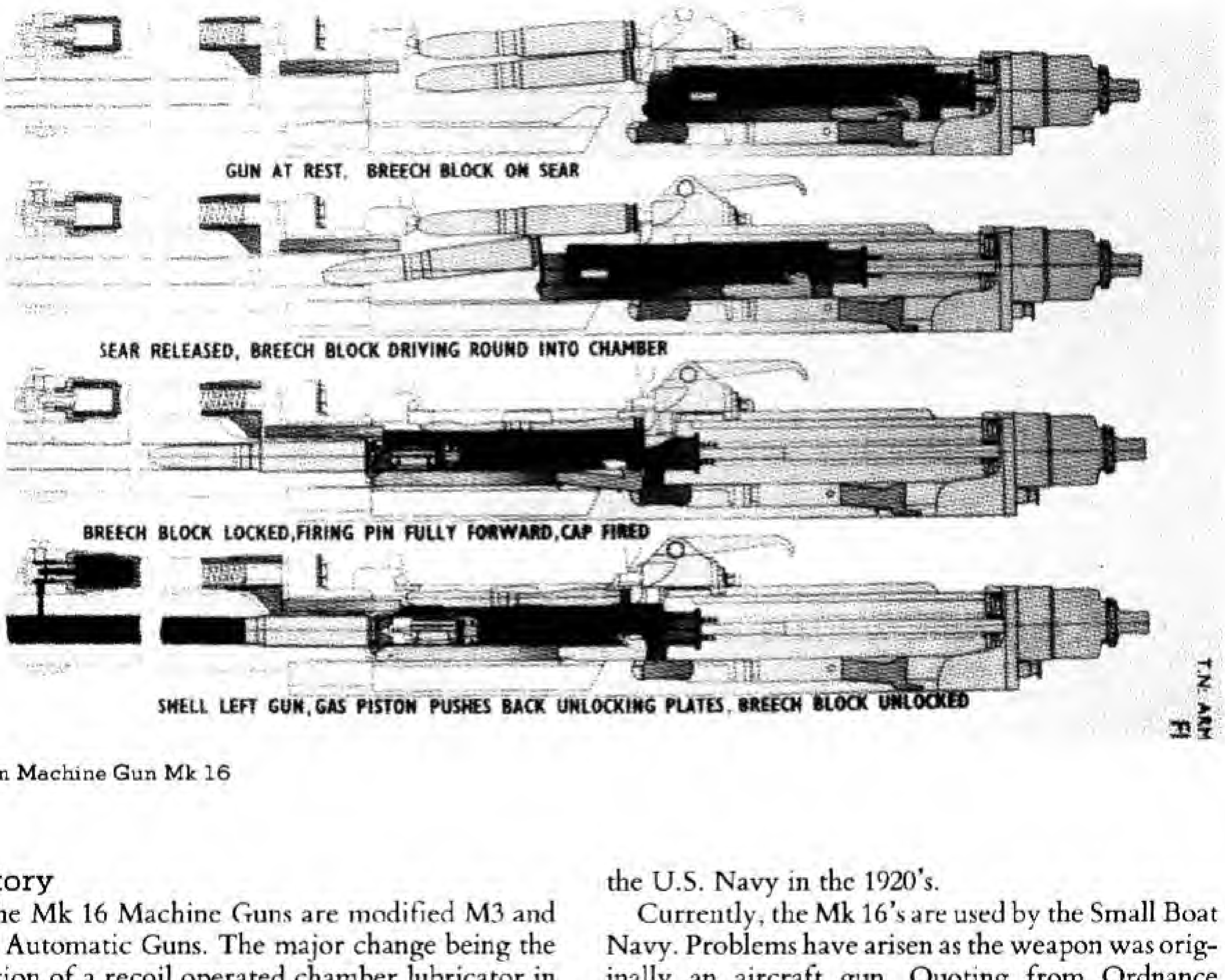


Ammunition: Ball, Tracer, Armour Piercing, Incendiary, Armour Piercing Incendiary, Blank Star, Drill (3).

Chapter 22

20mm Mk 16 Mods MACHINE GUN

HISPANO-SUIZA


GUN AT REST, BREECH BLOCK ON SEAR
SEAR RELEASED, BREECH BLOCK DRIVING ROUND INTO CHAMBER
BREECH BLOCK LOCKED, FIRING PIN FULLY FORWARD, CAP FIRED
SHELL LEFT GUN, GAS PISTON PUSHES BACK UNLOCKING PLATES, BREECH BLOCK UNLOCKED
T.N. ARM
FI

20mm Machine Gun Mk 16

History

The Mk 16 Machine Guns are modified M3 and M24 Automatic Guns. The major change being the addition of a recoil operated chamber lubricator in order to eliminate the need to hand lubricate the ammunition.

No complete guns have been produced since the end of World War II.

The history of the Mk 16's can easily be traced to the 20mm Birkigt type 404 Aircraft Gun, a product of the Hispano-Suiza firm which was introduced by the U.S. Navy in the 1920's.

Currently, the Mk 16's are used by the Small Boat Navy. Problems have arisen as the weapon was originally an aircraft gun. Quoting from Ordnance reports:

> "The gun should be fired in short, three to four round bursts. Continuous firing rapidly depletes the ammunition supply, may cause smoke that obscures the vision of the gunner, and causes overheating which increases the danger of cookoffs and accelerates erosion of the bore."

Description and Purpose

The 20mm Machine Gun Mk 16 Mods 4 and 5 are basically identical. They are modified M3 and M24 20mm Automatic Guns.

The major difference between the 20mm machine gun Mk 16 Mod 4 and Mod 5 is the means of actuating the sear. The Mod 4 sear is actuated by an electric solenoid. This sear can also be actuated by installing a manual override lanyard to the solenoid pull shaft. The Mod 5 sear is actuated by a sear release assembly and manual firing lever located on the gun mount. Designs for sear release assemblies vary with the application.

The Mk 16 Mods 4 and 5 are automatic, air cooled, weapons, which are gas unlocked. Another major difference between these guns and the M3 and M24 automatic guns is the incorporation of an automatic chamber lubricator. The guns use the feed mechanism M2E7 LH or RH and charger M6 (Modified) which are added to the basic gun. These guns use M90 series ammunition in M8 or M10 links.

The 20mm machine gun Mk 16 Mod 4 is designed to be installed on naval craft, primarily for use against shore and surface targets. The gun requires a 28 VDC power source. The 20mm machine gun Mk 16 Mod 5 is also designed to be installed on gun mounts employing manual triggers, mounted on board naval craft, primarily for use against shore and surface targets. These guns are capable of firing incendiary, tracer, and armor-piercing ammunition to a maximum range of 7000 yards.

Cycle of Operation

In an automatic gun, the firing of a cartridge furnishes the energy to carry on the cyclic functioning of the machine gun to fire succeeding cartridges. The machine gun must first be manually cocked by the charger. Then to initiate the cycle of operation the sear must be pulled free of the breechblock lock, allowing the breechblock to move forward into the battery position. This function is performed in the 20mm machine gun Mk 16 Mod 4 by an electric trigger. Depressing the trigger switch energizes the solenoid assembly of the electric trigger, pulling the sear down and free of the breechblock lock. In the Mod 5, the sear is pulled free by the sear release assembly, activated by a manual firing lever. Squeezing the firing lever pivots the trigger cam downward, camming the trigger lever, which pulls the sear free from the breechblock lock by the sear pull.

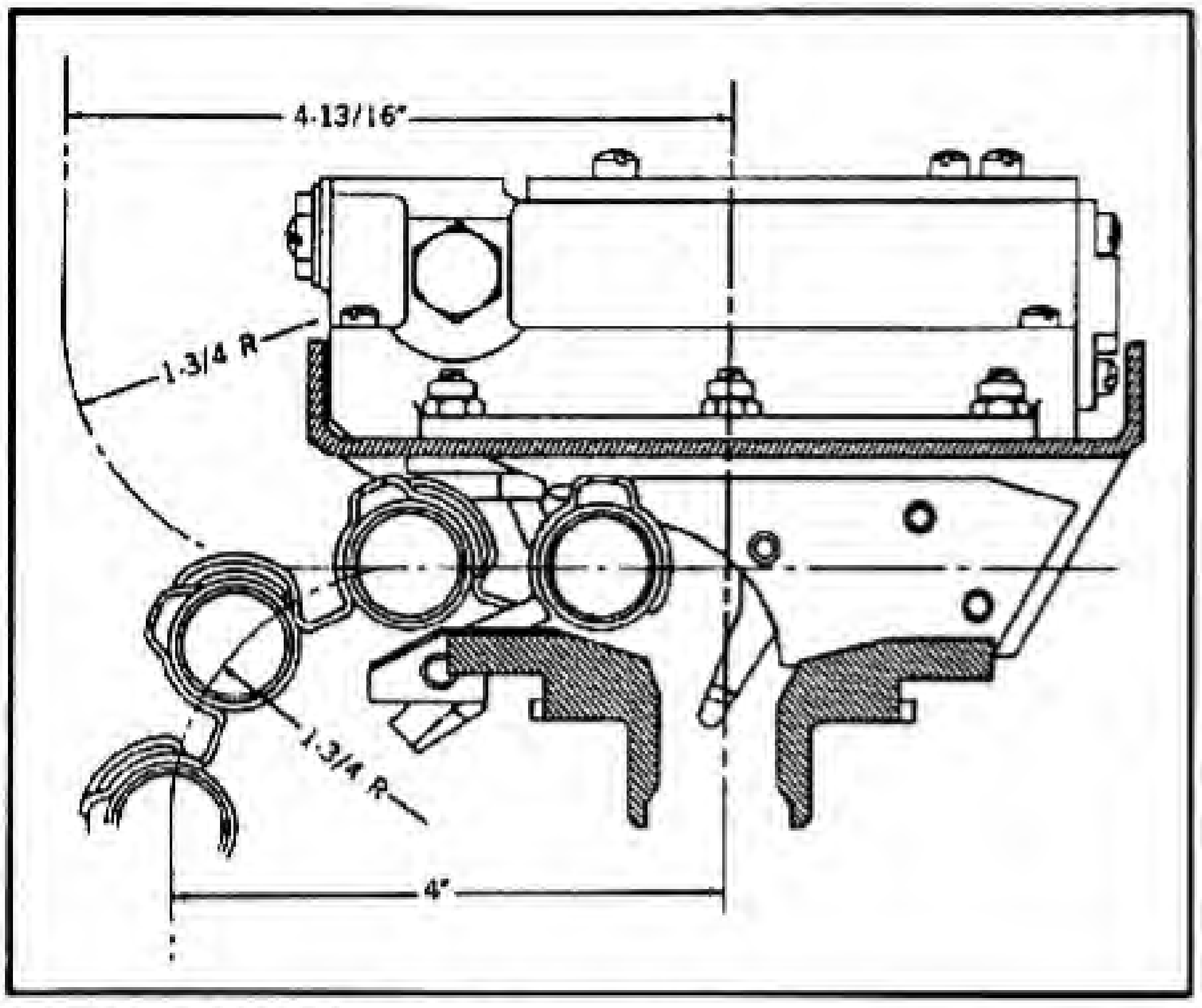
As the breechblock is moved forward by the action of the driving spring, it engages the incoming cartridge, which has been positioned in the feed mouth of the feed mechanism. This cartridge was forced downward into the feed mouth when the machine gun was cocked and the breechblock had sufficiently cleared the feed mechanism.

Characteristics

Bore Size	20mm
Muzzle Velocity	2840 fps
Rate of Fire	850 rpm
Basic Systems of Operation	Gas
Locking System	Propped Lock
Power Source Feed System	Recoil
Feed System	Sprocket Type
Type of Feed (location)	Link
Method of Chambering	Ram
Type of Accelerator	None
Initial Extraction	Oiled cases
Type of Receiver	Machined
Weapon by Source	U.S. Navy
Developer	Hispano-Suiza
Utilization	Surface
Ammunition Type	M90 Series, M10 or M8E1
Length	77.75 in.
Weight	97.5 lb.
Barrel Length	52.5 in.
Barrel Weight	26.2 lb.
Number of Grooves	9
Depth of Grooves	0.05 in.
Width of Grooves	0.205 in.
Grooves Pitch	7° R.H.

Near the completion of the breechblock closing stroke, the cartridge drops into the recess in the front of the bolt and is forced into the gun chamber. As the cartridge is chambered, the extractor claw grips the bottom of the cartridge case rim.

When the breechblock reaches the end of its forward motion, it seats against the rear face of the gun barrel, thereby closing the chamber. The action of the slide springs, combined with the momentum of the slides, causes the slides to continue forward after the breechblock stops. Simultaneously, the projecting cams on each side of the breechblock lock are engaged by the cam surface on the receiver slides. The action of the cams on the bevel of the breechblock lock forces the lock to rotate downward. The breechblock lock seats against the breechblock locking key in the receiver and is held in this position by the rear lower surface of the breechblock slides bearing on the rear end of the lock.



Angles of Entrance of Ammunition

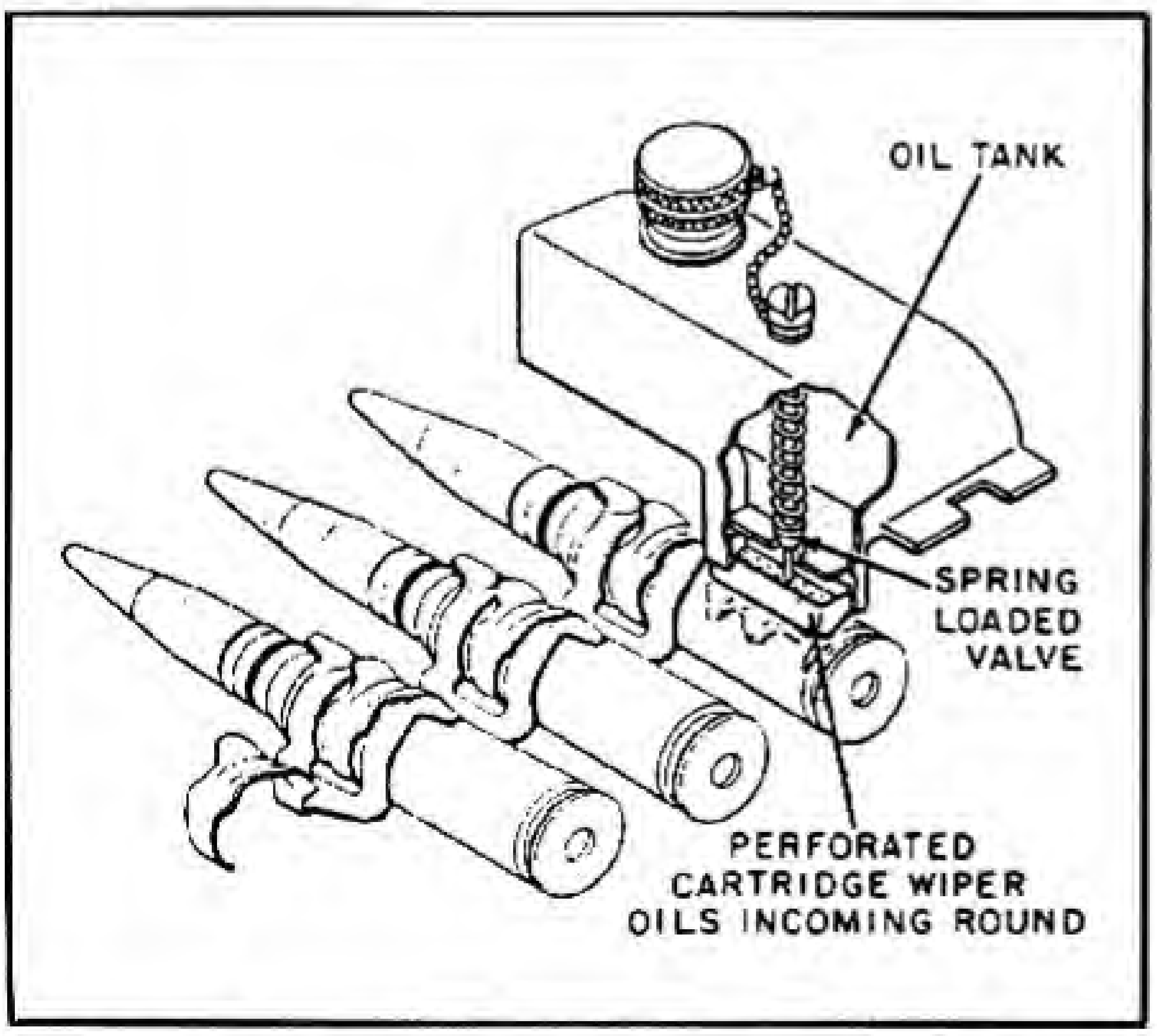
The firing pin is carried forward by the breechblock slide key, attached to the breechblock slides, and by the force of the expanding driving spring. This action causes the firing pin to strike the primer and fire the cartridge. When the slides have reached the end of their forward motion, the inertia blocks continue to move forward in their slots until they strike the forward end of the slots. This eliminates any tendency of the slides or firing pin to rebound.

During the automatic firing, the electric trigger on the Mod 4 or the sear release assembly on the Mod 5 holds the sear downward, away from the breechblock lock. This allows the breechblock to move through its cycle without being engaged and held in the cocked position.

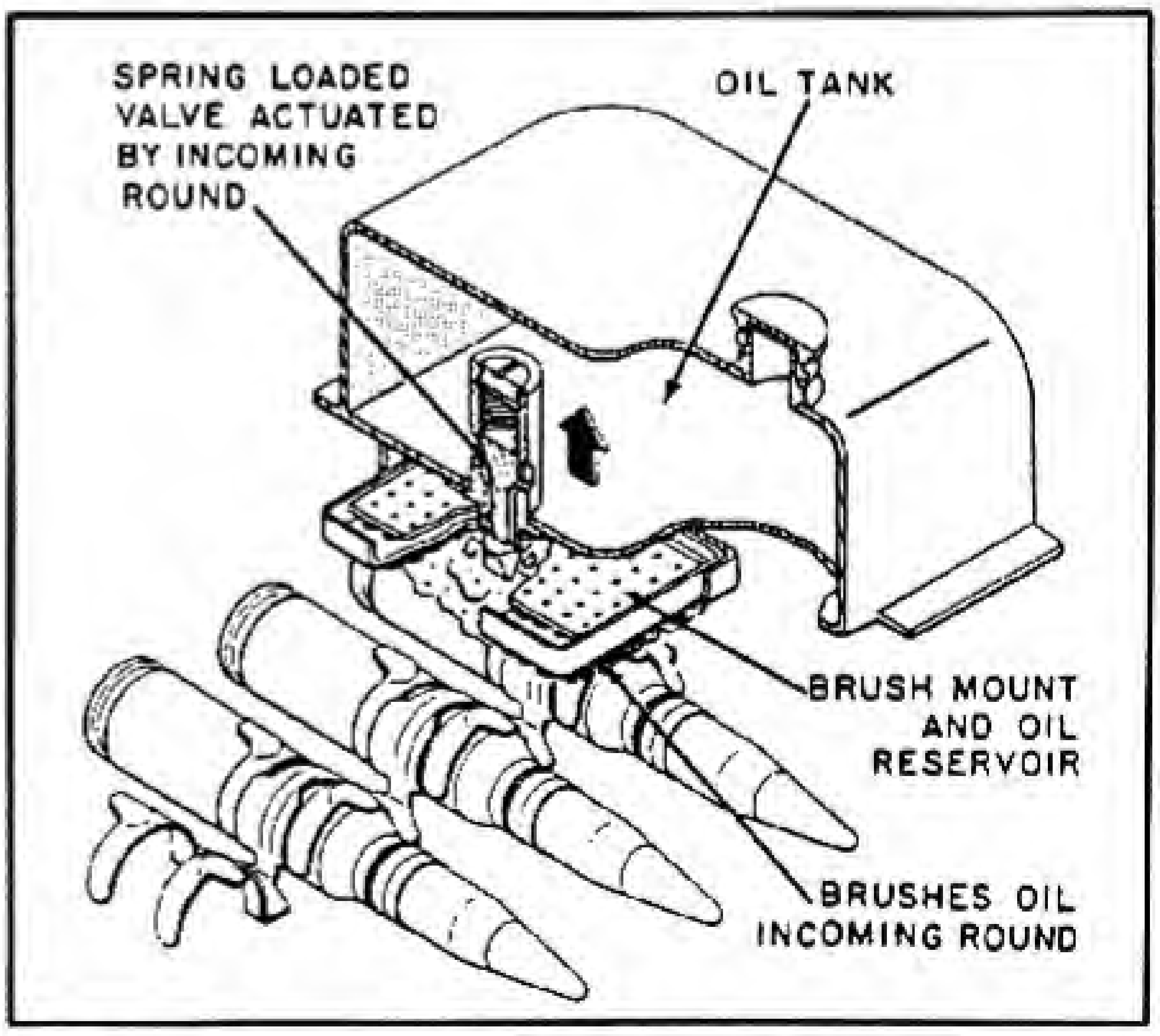
To stop firing the Mod 4, the trigger switch is released, allowing the sear to be forced upward by pressure from the sear spring plunger and sear return spring. To stop firing the Mod 5, the manual firing lever is released, allowing the sear to be forced upward by pressure from the sear release block spring. The sear has an upward projection on its top surface which engages the recess in the breechblock lock, thus holding the breechblock in the retracted position.

When the cartridge is fired, pressure of the propellant gas in the gun barrel forces the machine gun to recoil in the following manner: the front recoil spring seat and the barrel move to the rear, compressing the recoil spring until the rear of the front recoil spring seat contacts the front of the rear recoil spring seat. This contact prevents further compression of the recoil spring.

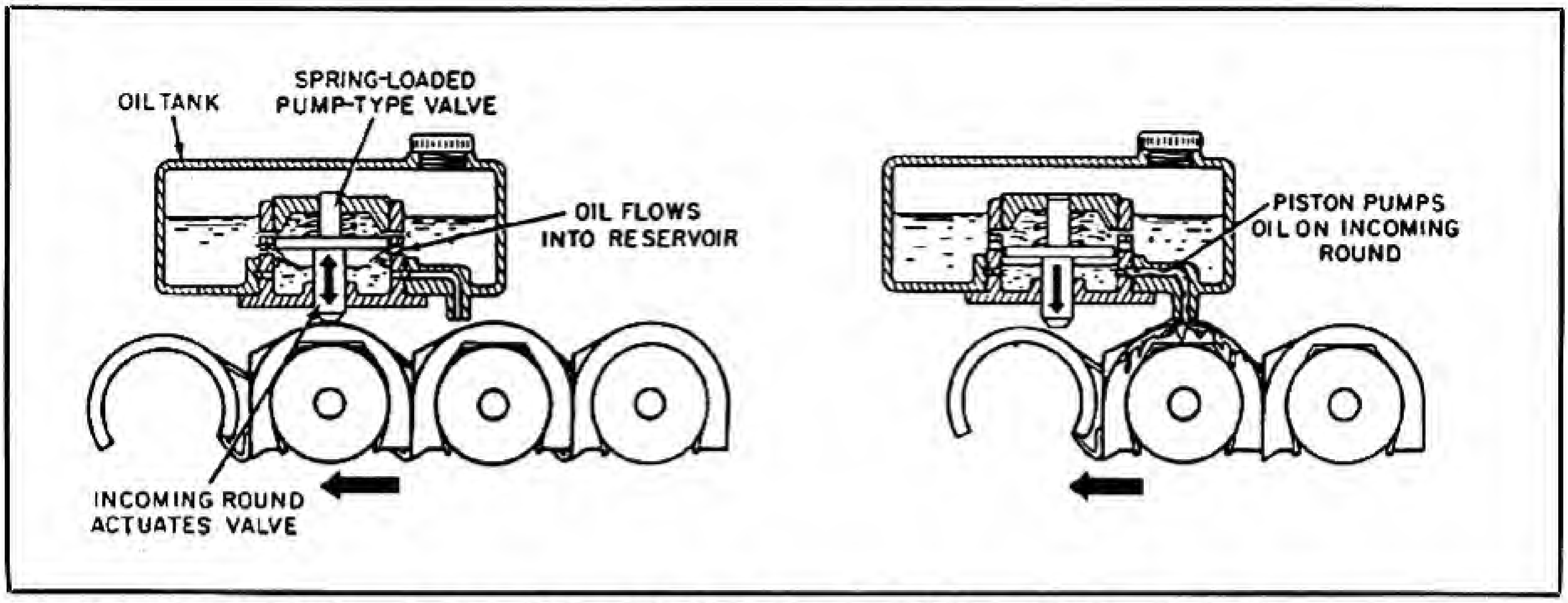
In this first phase of recoil, the recoil spring has absorbed part of the shock. The rear of the rear recoil spring seat is in contact with the front follower of the recoil housing assembly. The rear of the follower is adjacent to the front of the ring spring in the recoil housing assembly. The remaining shock of recoil is thereby transmitted to the ring spring. While the ring spring is being compressed, the recoil spring



Oiler Valve Actuated by Movement of Cartridges Through Feedway


SPRING LOADED VALVE ACTUATED BY INCOMING ROUND
OIL TANK
BRUSH MOUNT AND OIL RESERVOIR
BRUSHES OIL INCOMING ROUND

Oiler Valve Actuated by Movement of Cartridges Through Feedway, Wetting the Wiper Brushes.


OIL TANK
SPRING-LOADED PUMP-TYPE VALVE
OIL FLOWS INTO RESERVOIR
INCOMING ROUND ACTUATES VALVE
PISTON PUMPS OIL ON INCOMING ROUND

Oiler Valve Actuated by Incoming Round. Pump Oils Next Round as Belt Moves Out from Under Plunger.

begins to recover and the gun is moved forward in counterrecoil.

The recoil housing assembly ring spring acts as a buffer during counterrecoil, should the machine gun travel forward past its battery position. The ring spring is compressed in the same manner as on recoil motion of the machine gun. However, the action of the parts is exactly reversed to return the machine gun to the battery position. Thus, the energy of counterrecoil is absorbed and the machine gun is returned to the battery position.

At the moment of firing, the breechblock is held against the breech of the gun barrel by the breechblock lock resting on the breechblock locking key. The breechblock slides prevent the breechblock lock from disengaging until after firing.

The action of the gas mechanism unlocks the breech. As the projectile is driven forward in the gun barrel, it passes the gas port. A portion of the expanding propellant gas enters the gas port and passes into the cylinder section of the gas cylinder bracket. The gas passes through the hole in the vent plug and exerts pressure on the gas cylinder sleeve assembly. As the gas expands against the gas cylinder sleeve assembly, it forces the assembly to the rear, compressing the gas cylinder sleeve spring. As the gas cylinder sleeve assembly is forced to the rear, the yoke on the rear end of the sleeve assembly contacts the two push rods and forces them rearward. The push rods, in turn, contact the breechblock slides and force the slides to move rearward.

The breechblock slides are connected by the breechblock slide key which actuates the firing pin. The firing pin is notched to fit over the breechblock slide key. Therefore, as the breechblock slides move rearward, the breechblock slide key retracts the firing pin.

As the slides near the end of their rearward motion, the rear lugs of the breechblock lock are uncovered, allowing the lock to rise clear of the breechblock locking key, thereby unlocking the breechblock.

After the breechblock is unlocked, it is started toward the rear by the blowback action of the expanding gas remaining in the gun barrel. As it moves to the rear, it causes a drop in the gas pressure in the gun barrel. When the gas pressure drops, the gas cylinder sleeve spring expands, returning the gas cylinder sleeve assembly to its original position. The extractor claw engaged with the bottom edge of the empty cartridge case, aids in withdrawing the case from the chamber.

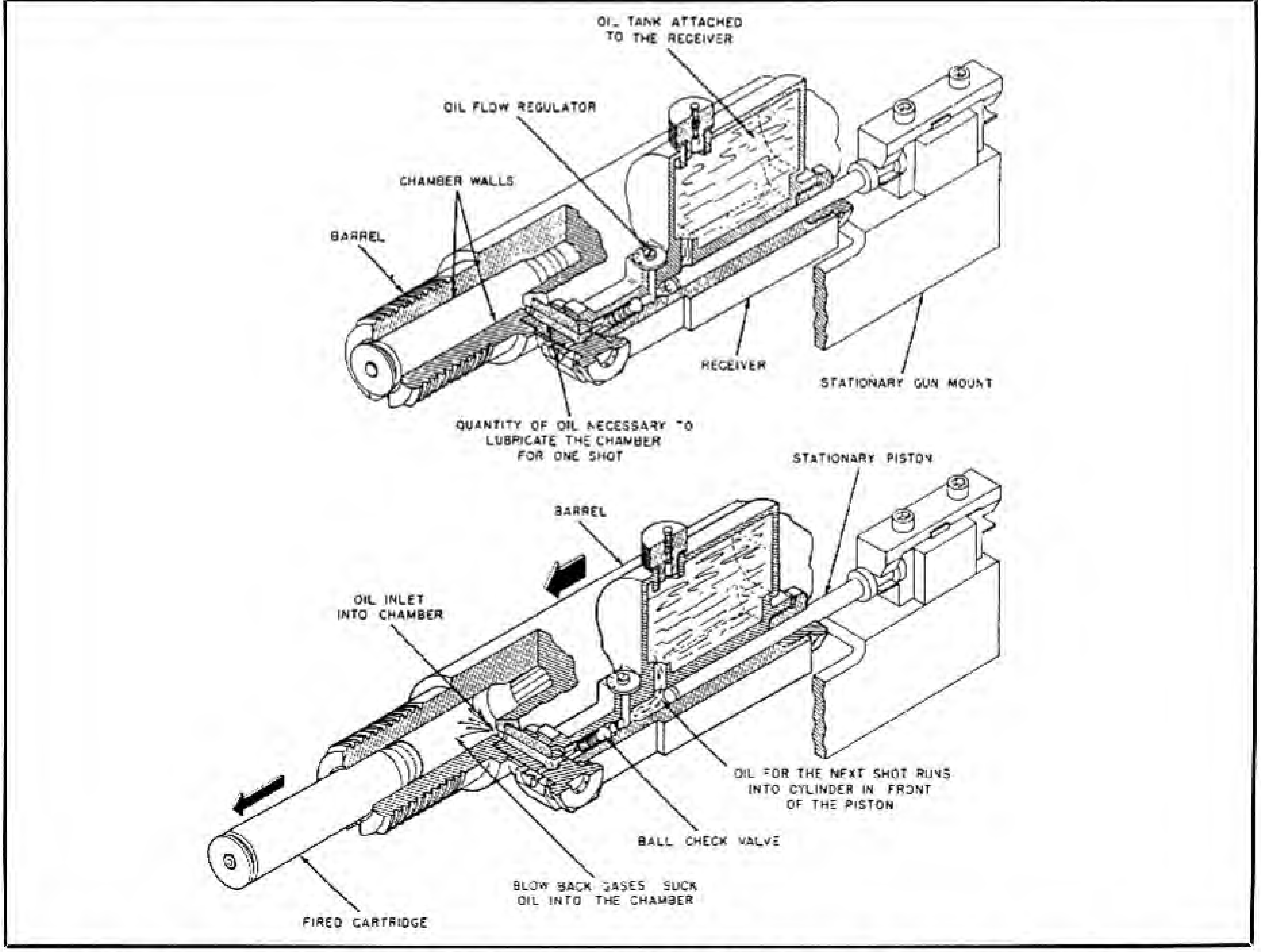
As the breechblock is forced to the rear, the empty cartridge case is pulled back with the breechblock by the extractor claw pulling against the cartridge case rim. Near the completion of the breechblock rearward motion, the upper edge of the empty cartridge case contacts the two ejector prongs. This action forces the empty cartridge case to pivot downward over the forward end of the extractor and through the openings in the bottom of the receiver and cradle.

During ejection, the front of the extractor is forced downward, thereby compressing the extractor spring. After the empty cartridge case is free of the extractor, the extractor spring returns the extractor to its original position.

When the breechblock has cleared the feed mechanism, another cartridge is forced downward into the feed mouth by the driving spring of the feed mechanism. In recoiling, the breechblock passes under the incoming cartridge and compresses the driving spring of the machine gun. Near the end of the breechblock movement, it strikes the rear buffer washer which transmits the remaining force of recoil to the buffer springs. This brings the breechblock to a stop.

The inertia blocks, however, continue to move rearward in their slots in the breechblock slides until they reach the end of the slots. By this time the rear buffer springs and driving spring, which were compressed during recoil, have started to expand and drive the breechblock forward. The inertia blocks remain in the rearward positon, relative to the breechblock slides, during the forward motion of the breechblock and slides.

During the rearward movement of the breechblock, if the sear is not held down by the electric trigger or the sear releases assembly, the breechblock passes over and depresses the sear. As the breechblock starts forward, the sear will engage a recess in the breechblock lock, holding the breechblock in the retracted position in the rear of the machine gun. The shock produced when the sear and the breechblock lock engage is absorbed by the sear buffer springs and the sear buffer blocks. When the electric trigger or the sear release assembly is actuated, pulling the sear down, the breechblock will move forward into the battery position by the action of the driving spring. The machine gun will continue to repeat its cycle of operation, if the sear is held free of the breechblock lock by depressing the electric switch or squeezing the manual trigger and if the ammunition supply is not exhausted.


OIL TANK ATTACHED TO THE RECEIVER
OIL FLOW REGULATOR
CHAMBER WALLS
BARREL
RECEIVER
STATIONARY GUN MOUNT
QUANTITY OF OIL NECESSARY TO LUBRICATE THE CHAMBER FOR ONE SHOT
STATIONARY PISTON
BARREL
OIL INLET INTO CHAMBER
OIL FOR THE NEXT SHOT RUNS INTO CYLINDER IN FRONT OF THE PISTON
BALL CHECK VALVE
BLOW BACK GASES SUCK OIL INTO THE CHAMBER
FIRED CARTRIDGE

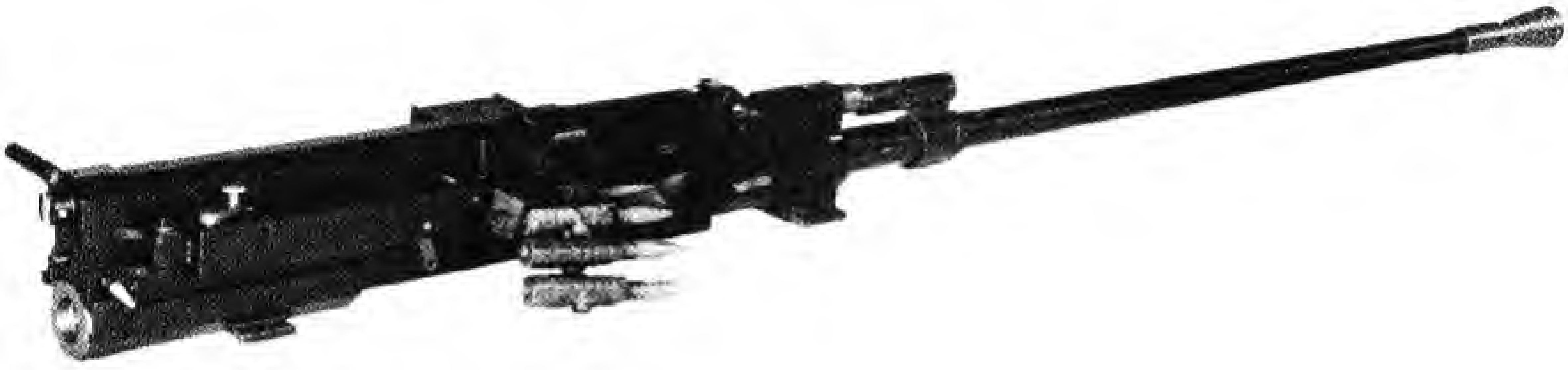
Blowback Gases Atomize Small Quantity of Oil, Lubricating Chamber. Oil is Pumped by Action of Recoiling Gun.

20mm Ammunition Fired During one Test using Chamber Lubricator and Ring Spring Mount.

Chapter 23

20mm AUTOMATIC ANTI-AIRCRAFT CANNON

OERLIKON KAA (FORMERLY 204Gk)



20mm Anti-Aircraft Cannon KAA

History

Oerlikon began development of the KAA 20mm gun shortly after World War II. The KAA had been used in a variety of mounts, including a low tripod for field use, a pedestal for ships, trains, or stationary defense, a quadruple self propelled mount built on a French AMX 13 tank chassis, and a ring mount for vehicles.

KAA also has been mounted on the Mowag Piranha APC in a turret.

In the first phases of the Bushmaster program several 20mm weapons were considered for the Interim Vehicle Rapid Fire Weapons System (VRFWS-I). The guns included the U.S. Navy Mk 12, the Hispano-Suiza 820, and the Oerlikon (called the 204Gk at that time). For a variety of reasons the HS 820 was selected in February 1962.

Since that time Oerlikon has produced the KAA for a number of countries and the weapon is in production.

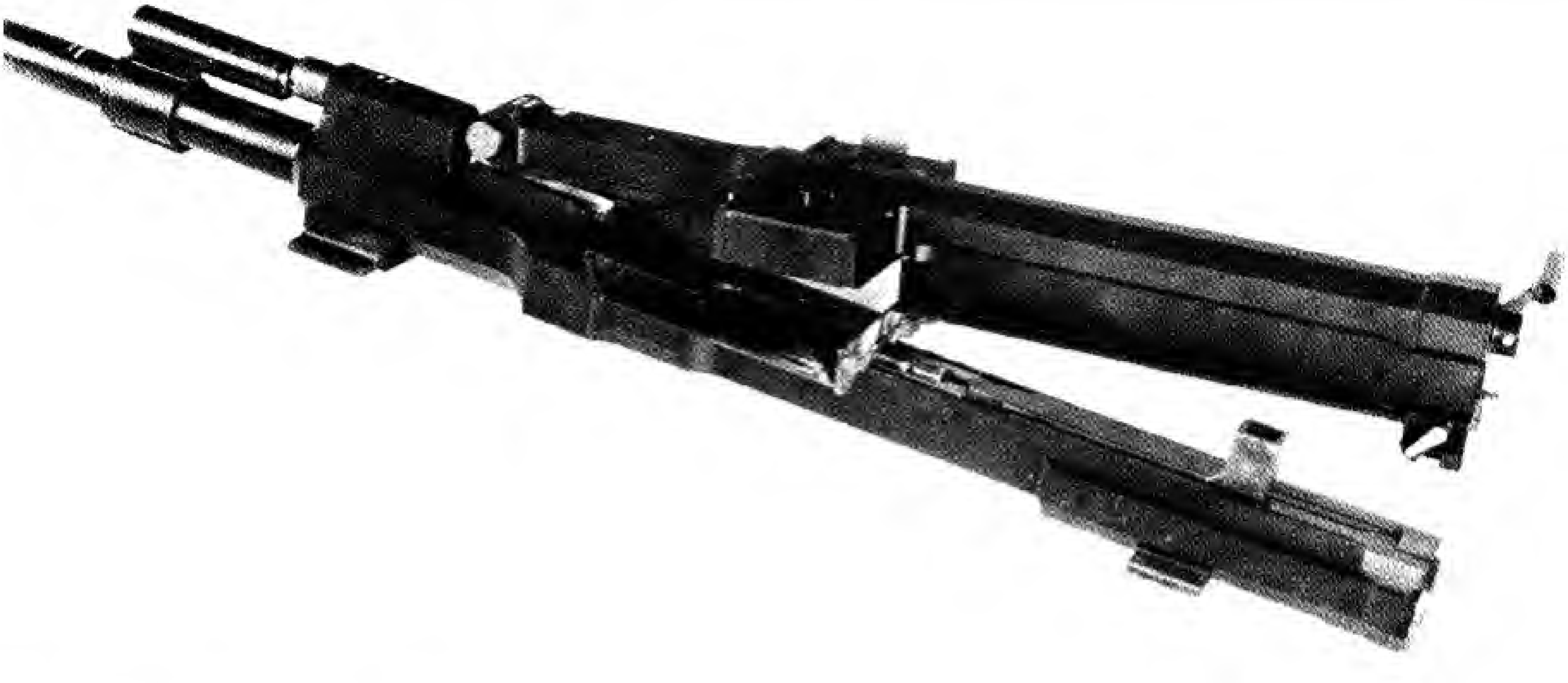
Description

The Oerlikon KAA 20mm automatic cannon is a single barrel, gas operated, air cooled, link-belt fed weapon. The feed mechanism is gas operated and the locking system is the Degtyarev type. This weapon is belt fed, and the feed can be from either side. Empty cartridge cases are ejected downward, and belt links are ejected on the side opposite the feed. The gun control cover, which operates the ammunition fed, does not recoil so that the ammunition feed is fixed in relation to the mount.

Charging of the gun is manual, by means of a built in ratchet. (Changing force is 10 kilograms.) Primary extraction is aided by the fluted chamber.

The gun is 103 inches long and weighs 203 pounds. The barrel is 72 inches long with muzzle brake and weighs about 60 pounds. A heavy weight barrel which weighs 72.5 pounds is also available.

The normal rate of fire of the KAA is 1,000 rounds per minute and the muzzle velocity varies from 3560



Oerlikon 204Gk with cover open

feet per second to 3900 feet per second depending on the ammunition type used.

The primary purpose of this weapon is for anti-aircraft use but it is also effective against ground targets, including personnel, unarmored and light armored vehicles.

Cycle of Operation

When the bolt is released by actuation of trigger, the charging spring drives the bolt forward by means of a lug on the spring housing which engages the bolt. The bolt drives the cartridge through the link and into the chamber.

The bolt head stops when it hits the stop inserts, the bolt tail continues forward under the effect of kinematic energy and forces the pivoting locks outward into locked position against the rear pair of lock inserts. A detent prevents the bolt tail from bouncing back.

Immediately upon reaching the forward position, the firing pin fires the round.

As the projectile passes the gas port, the gas pressure on the gas piston which drives the spring housing backward. The spring housing lug, which engages the bolt tail, pulls the bolt tail backward and releases the pivoting locks and unlocks the bolt.

In addition to the force exerted by the gas piston, the residual gas pressure in the barrel helps to force

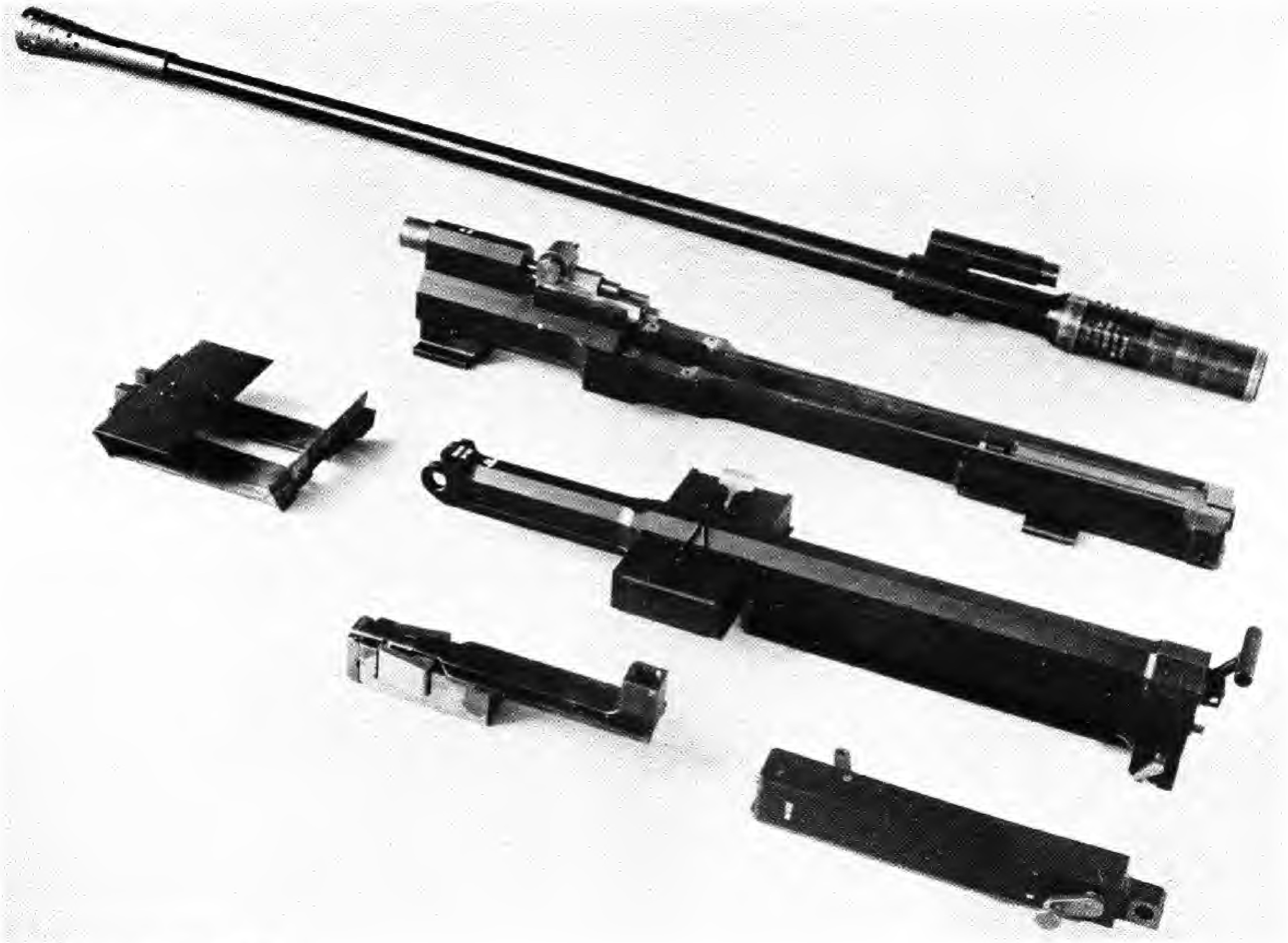
Characteristics

Calibre	20mm
Muzzle Velocity	1050 m/sec (3445 fps)
Rate of Fire – Single Fire or Automatic Fire	at 1000 rpm
Armor Penetration (with armor piercing shell)	(65mm) 2⅛" steel armor at 100 meter range
Length of Barrel	85 calibre
Rifling	12 grooves
Rifling – increasing twist from	0° to 6° 30′
Force rquired to Cock Gun	14-22 lbs. max. (7-10 kg)
Reaction of Trunnion during Automatic Fire	Approximately 750 lbs. (340 kg)
Barrel with Muzzle Brake	60 lb. (26.6 kg)
Receiver	58 lb. (26.4 kg)
Bolt	9 lb. (4.1 kg)
Cover Group	44 lb. (20.0 kg)
Trigger	12 lb. (5.4 kg)
Complete Gun, including Muzzle Brake	193 lb. (87.0 kg)

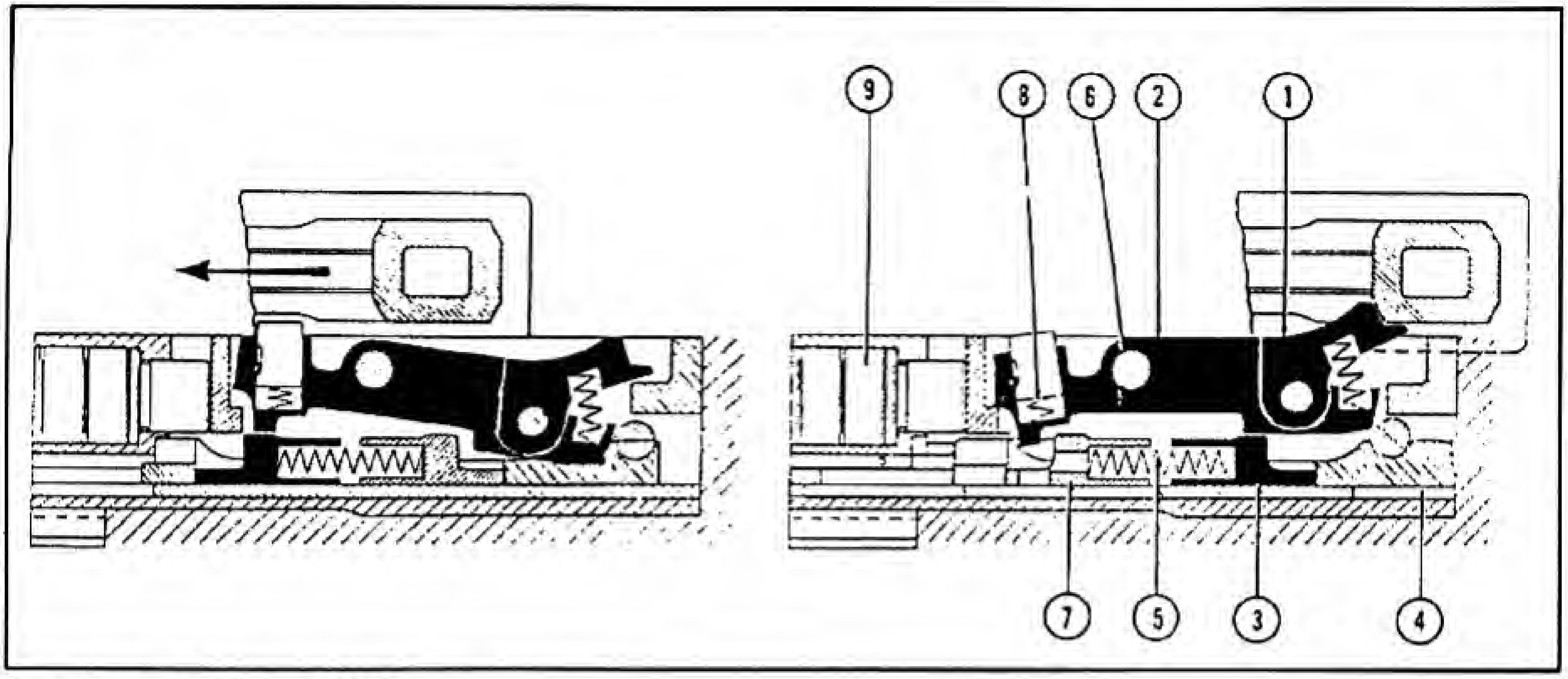
The above weights are for the gun with "light" barrel. For "heavy" barrel gun add 12½ lb. (5.7 kg).

Recoil Adapter Weight:

Complete	18¾ lb. (8.5 kg)
Recoiling Portion	13½ lb. (6.1 kg)



Main Components of 20mm KAA



Sectional View of Trigger Mechanism

1. Sear
2. Sear Support
3. Rear block piece
4. Trigger slide
5. Spring
6. Pivot
7. Front block piece
8. Spring
9. Trigger buffer

the bolt rearward.

The empty cartridge case, gripped by extractor, is withdrawn from the chamber and ejected down and out of the gun when the bolt passes the ejector. The bolt continues to the rear until it strikes the bolt buffer.

The feed roller has a spiral slot which is engaged by the lug on the spring housing. It is rotated by the forward and backward movement of the spring housing. Teeth on the forward end of the feed roller mesh with the teeth on the belt feed slide and move the slide from side to side as the feed roller is rotated.

When the spring housing is in the forward position, the belt feed slide is in a position to feed ammunition and the feed pawls on the belt feed slide engage the cartridge belt. After firing, the spring housing is driven back by the gas piston. The feed roller is rotated by this backward movement, and the belt feed slide, geared to the feed roller, pulls a new cartridge in front of the bolt.

The belt stop and belt holding pawls prevent the cartridge from slipping away when the bolt moves forward and the belt feed slide moves to grip a new cartridge. The cartridge deflector, part of the belt feed mechanism, brings the cartridge from the horizontal position into the slanted position necessary to feed it into the chamber.

In the "cocked" position the bolt is held back by the sear. The sear cannot be released as long as the sear support which carries it is blocked by the rear block piece.

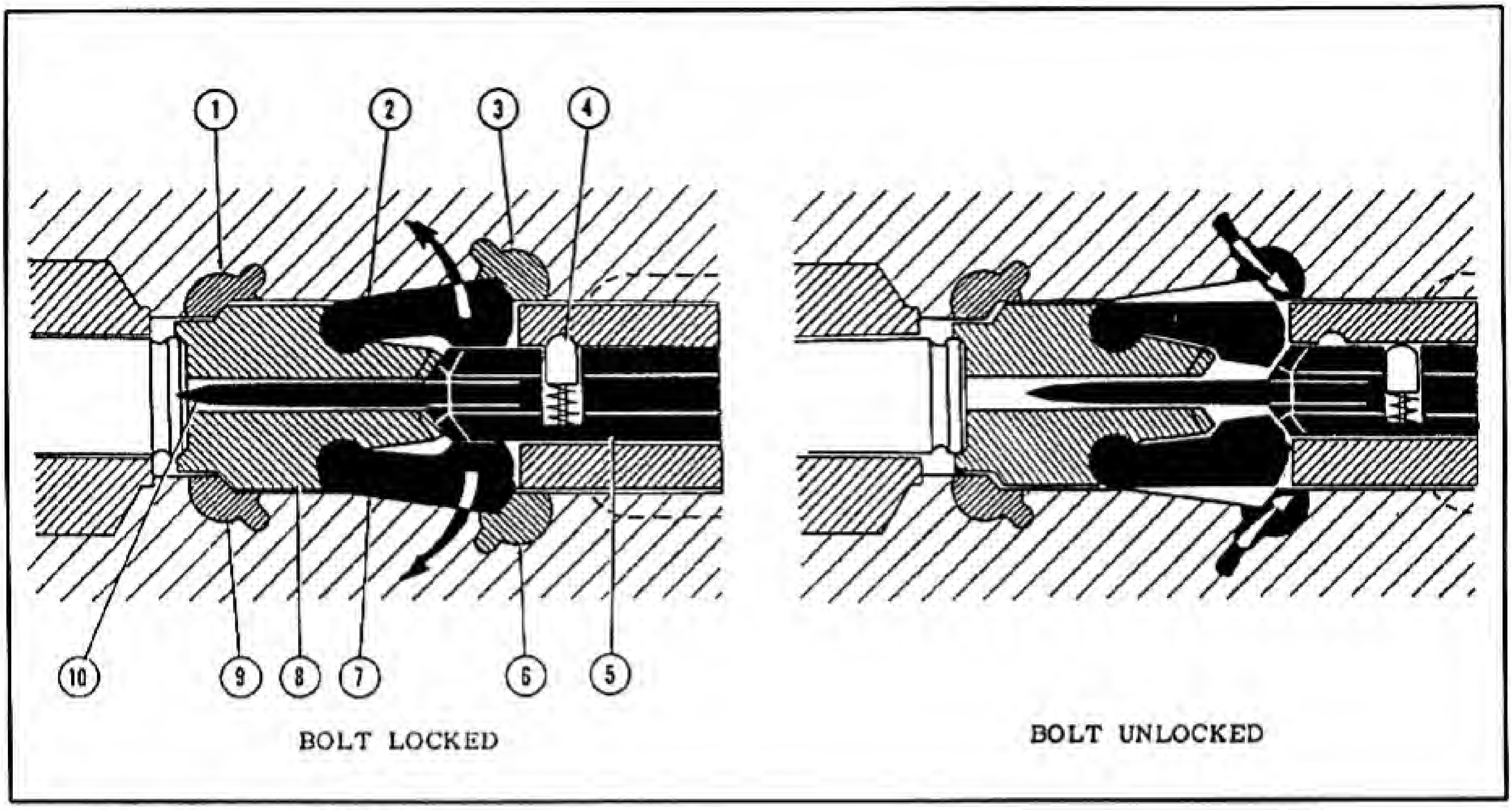
As the trigger is actuated and the trigger slide moves forward, the trigger slide pushes the rear block piece forward against the spring and releases the sear support which turns clockwise around a pivot.

Under the pressure of the spring, front block piece is pushed over the cam of the sear support and blocks it into firing position.

When the trigger is released and the trigger slide moves to the rear under the force of two springs, the sequence is reversed and the sear support is released. The sear support turns counterclockwise under the pressure of a spring and is again held by the sear block piece. The spring-loaded sear latches the bolt in the open position after the recoil movement is completed. The shock is absorbed by the trigger buffer.

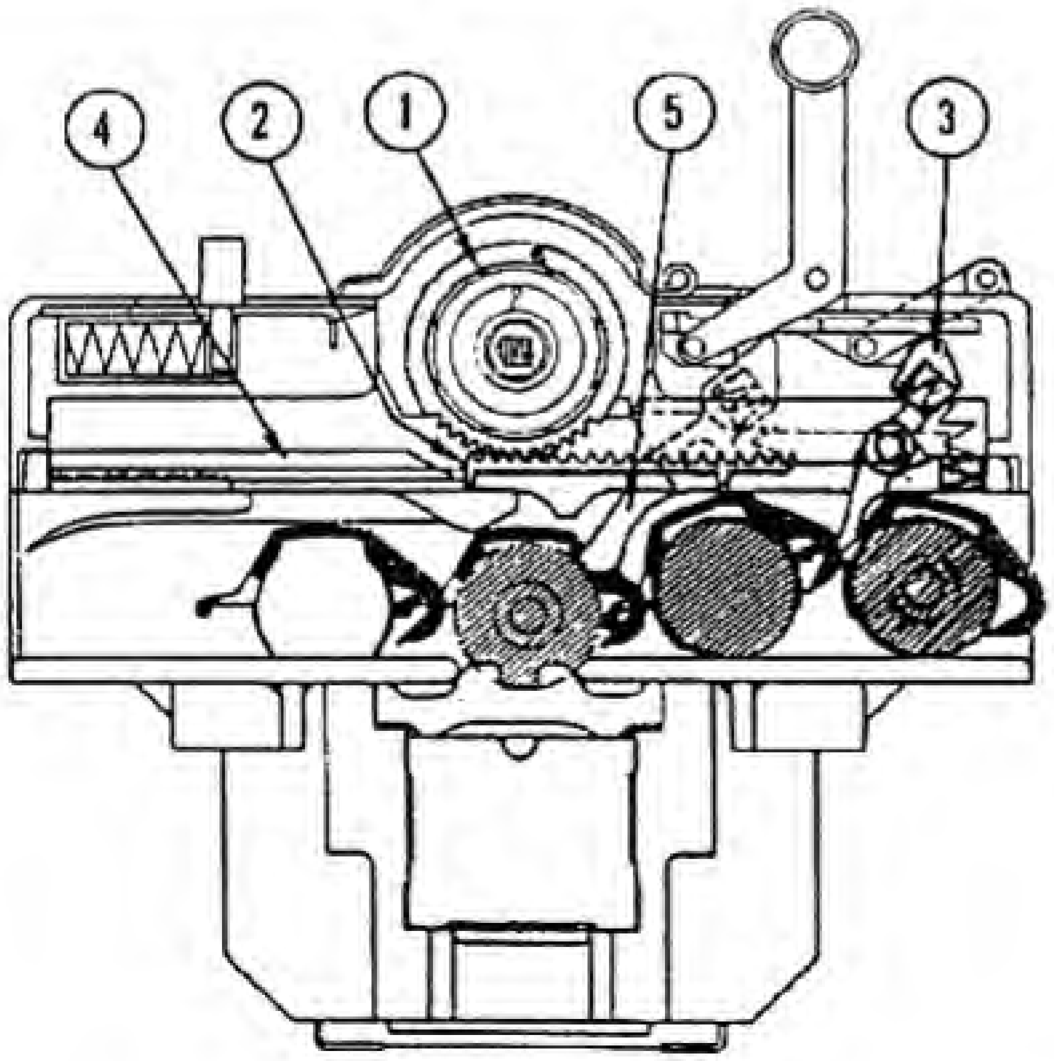
When the safety lever is turned to "safe," the shaft blocks the trigger slide so that the gun cannot be fired.

When the fire selector is turned to the single fire position, a flat on its shaft causes the trigger slide to return immediately after the trigger is pulled. Only one round is fired even if the trigger is held back. The trigger must be released and pulled again to get a second round.


1
2
3
4
10
9
8
7
6
5
BOLT LOCKED
BOLT UNLOCKED

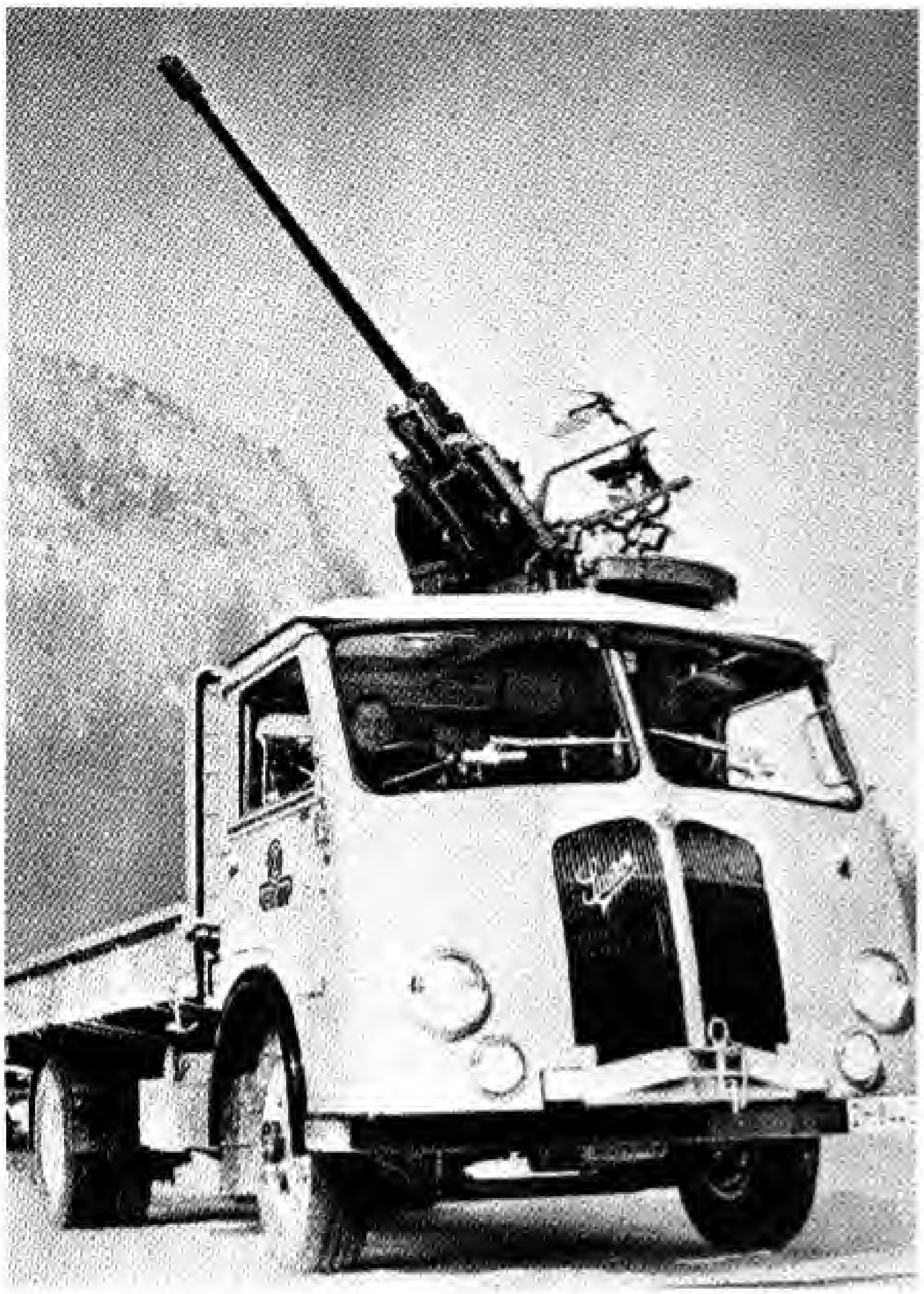
Sectional View Showing Bolt Action

1. Stop insert
2. Pivoting lock
3. Lock insert
4. Detent
5. Bolt tail
6. Lock insert
7. Pivoting lock
8. Bolt head
9. Stop insert
10. Firing pin

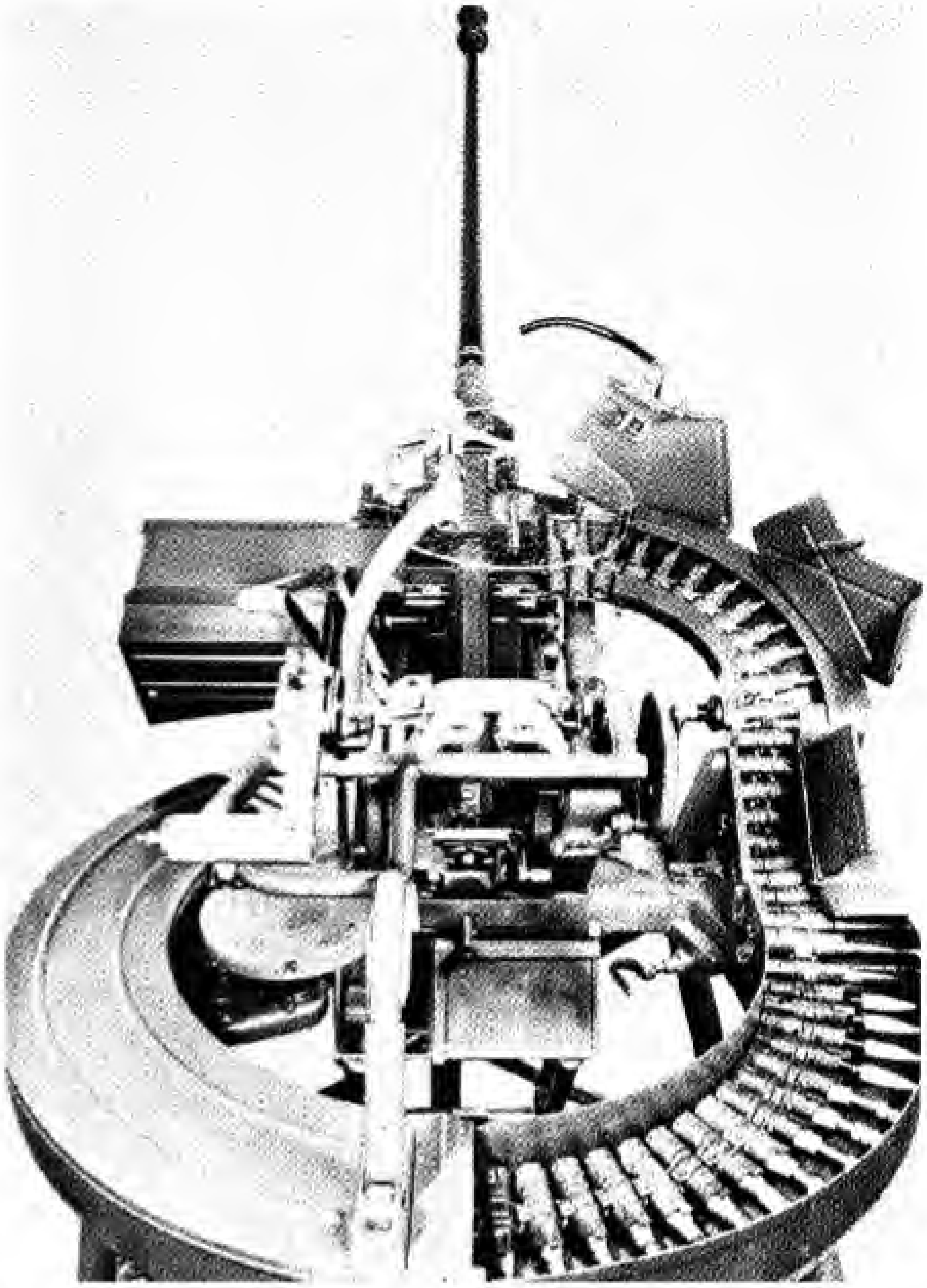


1. Feed roller
2. Belt feed slide
3. Feed pawls
4. Stop
5. Holding pawls

Sectional View Showing Ammunition Feed



Mounted 204Gk



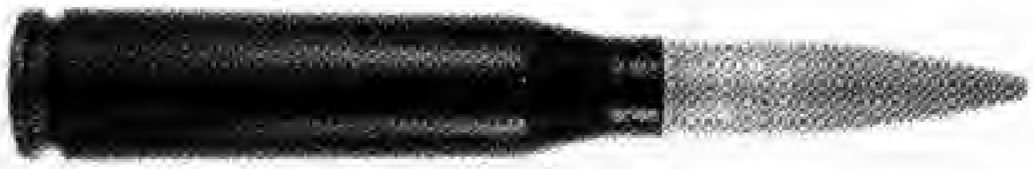
View of Gun in place

When the fire selector is turned to the automatic fire position, the flat on the selector shaft holds the trigger slide in firing position until the trigger is released.

The action of the trigger mechanism snaps and locks the sear in either full firing or full holding position.

Ammunition

The Oerlikon KAA 20mm 20 x 129 ammunition cartridge was developed by Oerlikon in 1943, and used in guns 5TG (=KAB), 204 Gk (=KAA), 206 Rk (electric-primed ammunition).



20 x 129 Oerlikon KAA 20mm Ammunition (Photo courtesy of Woodin Laboratories.)

Chapter 24

20mm T220 SHORT RANGE ANTI-AIRCRAFT GUN (PROJECT OCTOPUS)

SPRINGFIELD ARMORY

History

In the 1950's, a program was initiated to develop a new lightweight short range anti-aircraft weapon system. The project was known as the All-Arms Anti-Aircraft System, and was code named Project Octopus in September, 1956. The system was to be capable of being broken down into man portable pieces and was to be effective against low flying aircraft with speeds to 800 mph, at 1,000 feet maximum altitude, and 2,000 yards maximum range.

To fulfill the requirement for this program, the Ballistic Research Laboratories, Aberdeen Proving Ground recommended that a new 20mm weapon would be required. The military requirements led to the need for the features of low weight, self-powered operation, and short receiver design. The short receiver design was important because it was related to the necessary low trunnion height and the resulting mount stability and weight of the anti-aircraft mount.

One of the weapons designed to fulfill the requirement was the T220 20mm automatic gun, the development of which was begun at Springfield Armory in September, 1954. It was a modification of the T173 calibre .60 automatic gun, which, in turn, was a modified T17E5 calibre .60 aircraft machine gun.

Based on the feeding difficulties, work on the T220 itself was stopped in late 1956 or early 1957. Two separate attempts were made to extensively redesign the T220 while keeping the same basic rotating bolt locking mechanism. Those two weapons were the T247 designed by American Machine and Foundry and the T220E1 designed by Springfield Armory. One other gun, the T220E2 was built by Dixon Research. Project Octopus was terminated in 1958. The project could be regarded as the predecessor to the Bushmaster Project which began a few years later.

Description and Purpose

The purpose of the gun was to meet the requirements for a short range anti-aircraft gun.

The T220 was a recoil-operated, air-cooled, belt-fed weapon with a dual rate of fire; 1,500 rounds per minute for anti-aircraft fire and 500 rounds per minute against ground targets. The gun operated on the short-recoil principle at the high rate of fire and on the long-recoil principle at the low rate. The T220 and T173 had short receivers, but the bolt of the T220 was larger than that of the T173. The gunner selected the rate of fire on the T220 by moving a selector lever at the front of the receiver.

Cycle of Operation

After a round was fired at the low rate, the barrel group and the locked bolt group of the T220 recoiled about 10 inches. The bolt body was held by a sear when the barrel group struck the recoil buffer. On counterrecoil, an internal cam between the bolt body and the bolt head rotated the latter to unlock it from the barrel group. As the barrel group returned to battery, it released the sear, allowing the bolt to chamber and fire another cartridge. A claw at the bottom of the bolt head extracted the empty cartridges. An axial spring-loaded pin in the bolt head pressed against the top of the rim of the cartridge, which then pivoted about the extractor and tumbled out the bottom of the receiver as soon as the front of the case cleared the barrel extension. The T220 used energy from the barrel group, not from the bolt (as in the T173), to actuate the feeding mechanism. The feeding cam and linkages functioned in the same way regardless of the rate of fire, and the gun employed the T51 link. The operation of the T220 when fired at the high rate of fire was similar to that of the T173.

Test Results

Significant feeding problems were encountered and after extensive detail modifications failed to result in a satisfactory solution, the concept of changing the method of operation to obtain a dual rate of fire was rejected.

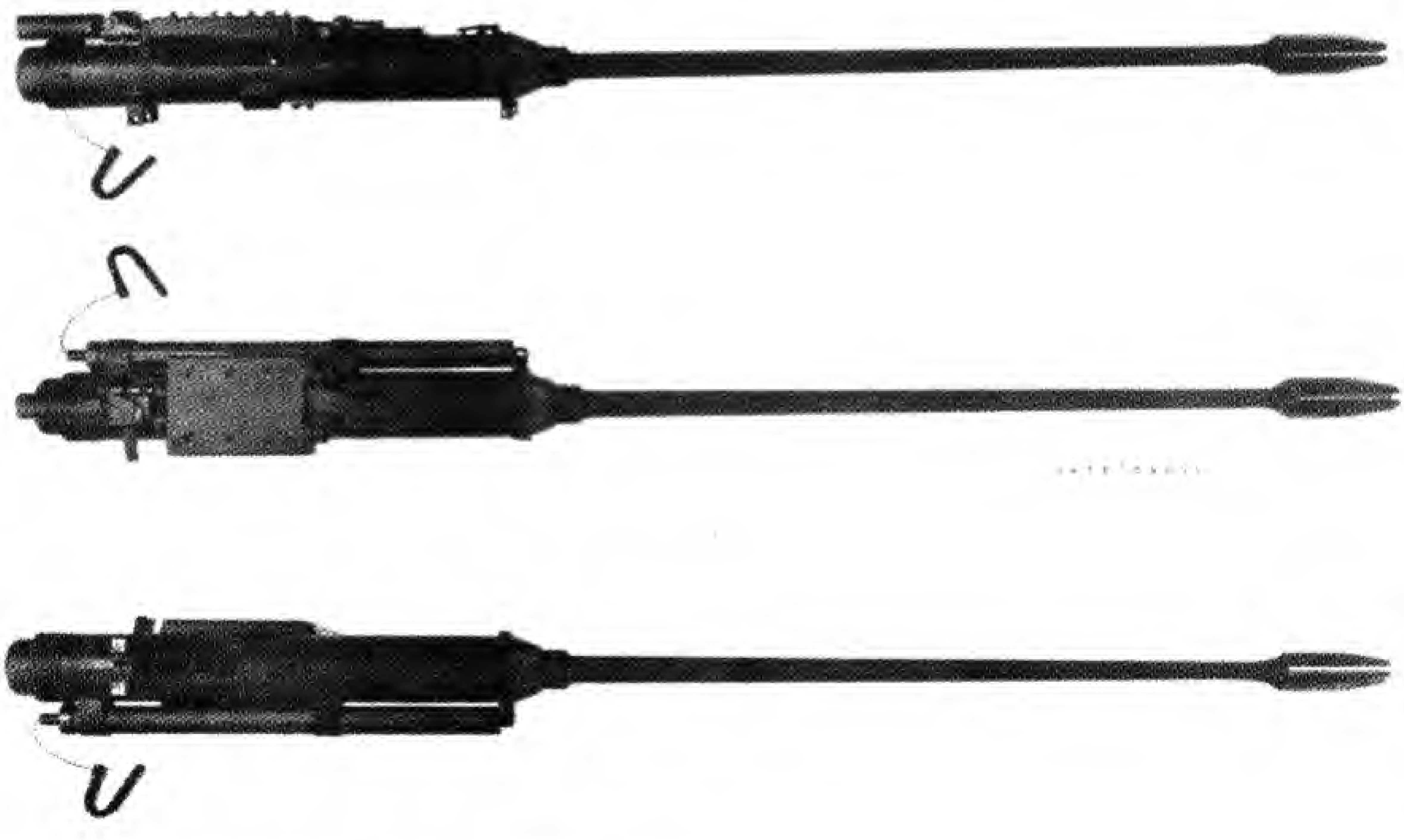
Ammunition

The ammunition was the M150 series, identical to the present M50 series Air Force round except for a percussion primer. The ammunition was made in steel and brass cased versions and fired a 1,530 grain projectile at 3,400 fps.

SECTION I.

20mm T220E1 SHORT RANGE ANTI-AIRCRAFT GUN

SPRINGFIELD ARMORY



20mm T220E1 Automatic Gun (Side, Top, and Bottom Views)

History

The development of the T220E1 occurred in the 1950's during the course of a project known as the All-Arms Anti-Aircraft System. The design that evolved during the program was an evolutionary change from the T17E5 machine gun and the T173 machine gun and was given the nomenclature T220. At the time of the program's termination in 1958, there were four distinct versions of that weapon the T220, the T247, T220E1, and T220E2.

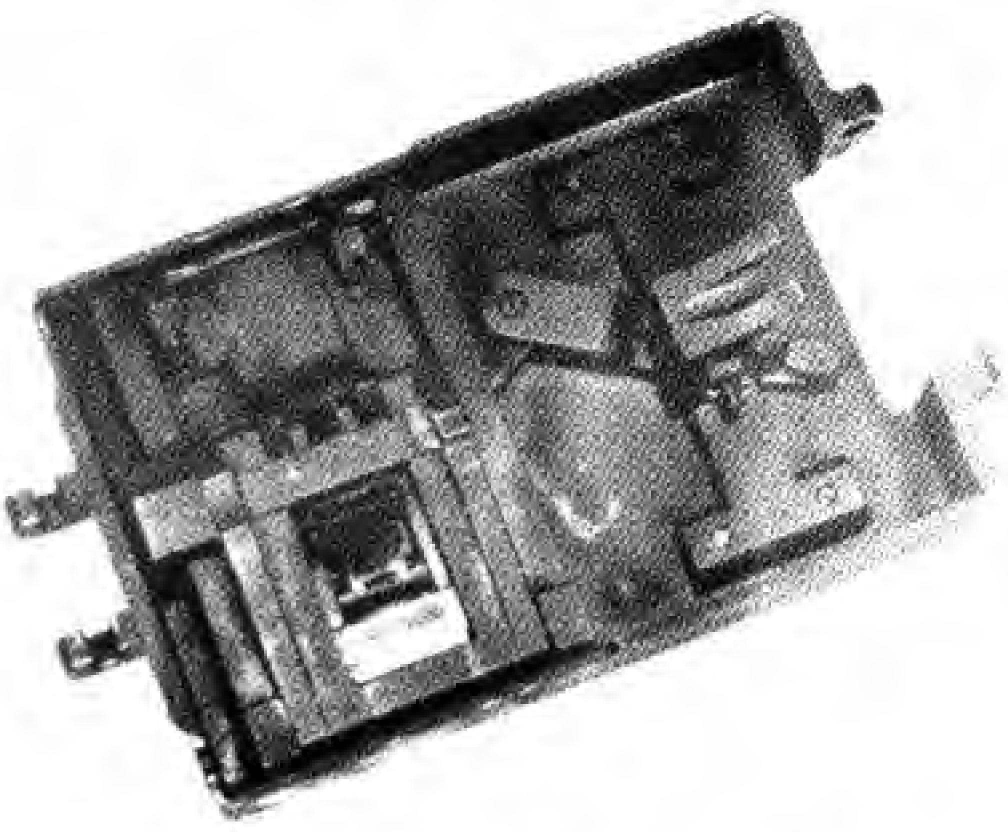
Thirteen guns, six for development and seven for engineering tests were fabricated. Two of the former were destroyed in testing.

Description and Purpose

The T220E1 is a 20mm short recoil operated, belt fed, rotating bolt lock, air cooled weapon designed to meet the requirements for a light-weight short-range anti-aircraft system, which was to be capable of being broken down into man-portable pieces, and effective against low-flying aircraft with speeds to 800 mph, at 1,000 feet maximum altitude, and 2,000 yards maximum range.

The complete gun weighs 102 pounds. The gun is 95.1 inches long, 7.2 inches wide and 6.9 inches high. The barrel, 60 inches long, weighs 27.5 pounds with the flash hider.

The high rate of fire was 1,100 rpm and the low rate was 500 rpm.

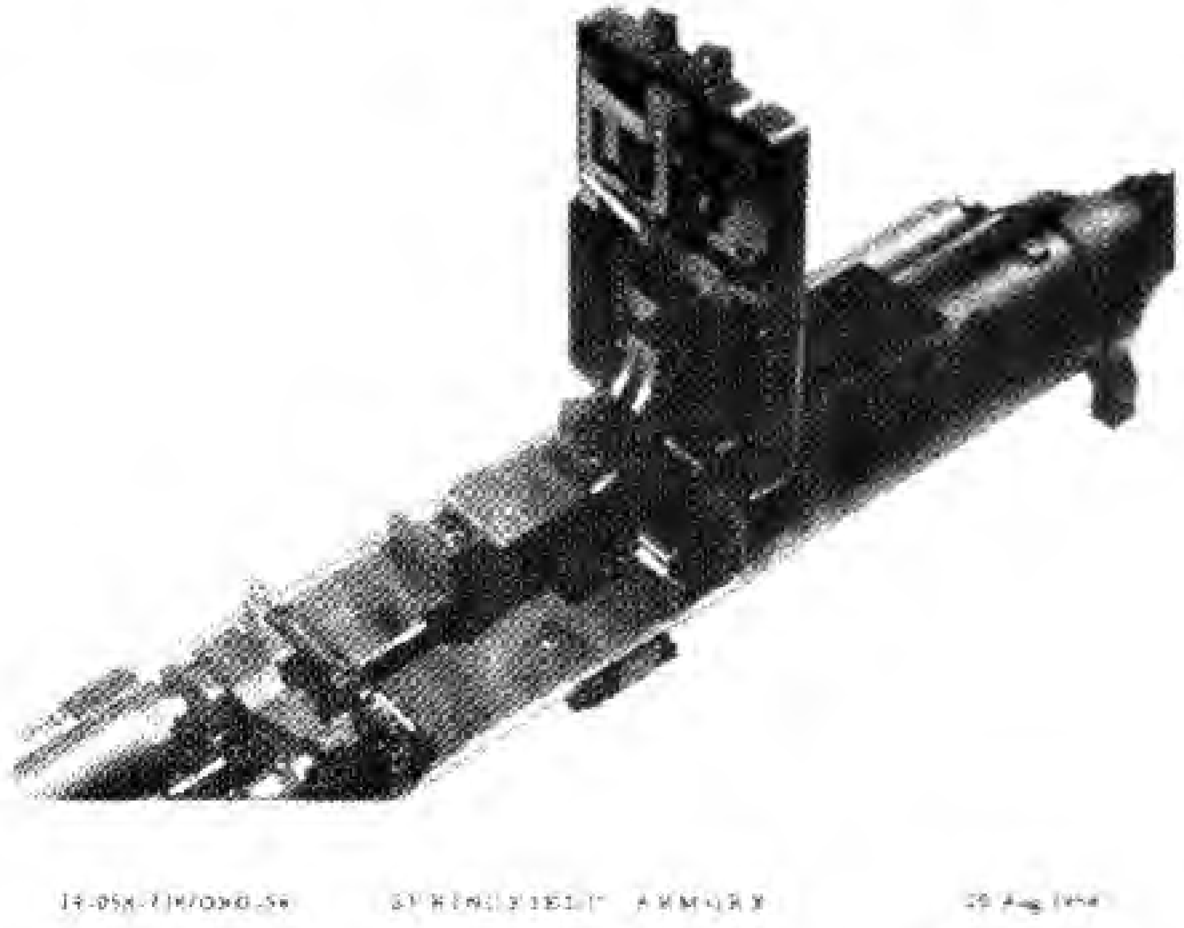


20mm T220E1 Automatic Gun Cover Assembly

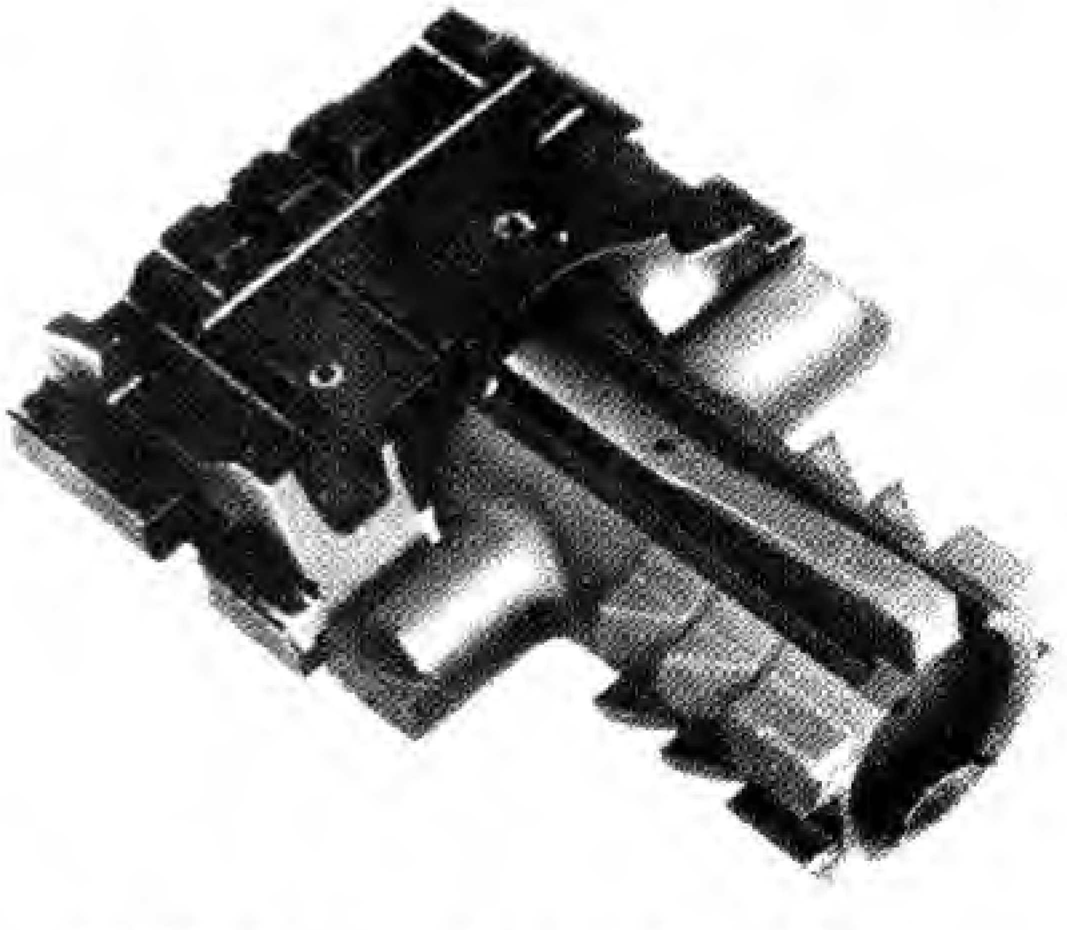
Cycle of Operation

To operate the T220E1 at the high rate of fire, the charging handle is first pulled to the rear. The cover is then opened, ammunition is placed in the feed tray, and the cover closed. When the trigger is pulled, the sear releases the bolt, which strips a round from the belt, chambers it, and fires it. After a round has been fired, the barrel, bolt, and breech ring recoil as a unit for about 0.22 inches, at which point the bolt begins to unlock from the breech ring. Cams then accelerate the rearward movement of the bolt body and rotate the bolt head until the bolt and bolt head separate from the breech ring (barrel group). When the barrel strikes the barrel buffer, the bolt group continues rearward, carrying the empty cartridge case to the ejector. During recoil, the barrel-return spring is compressed, and after the barrel hits the barrel buffer the spring drives the barrel forward into battery. At the end of recoil, the bolt group strikes the bolt buffer, which, along with the bolt-return spring, drives the bolt group forward in counterrecoil to chamber another round and fire it.

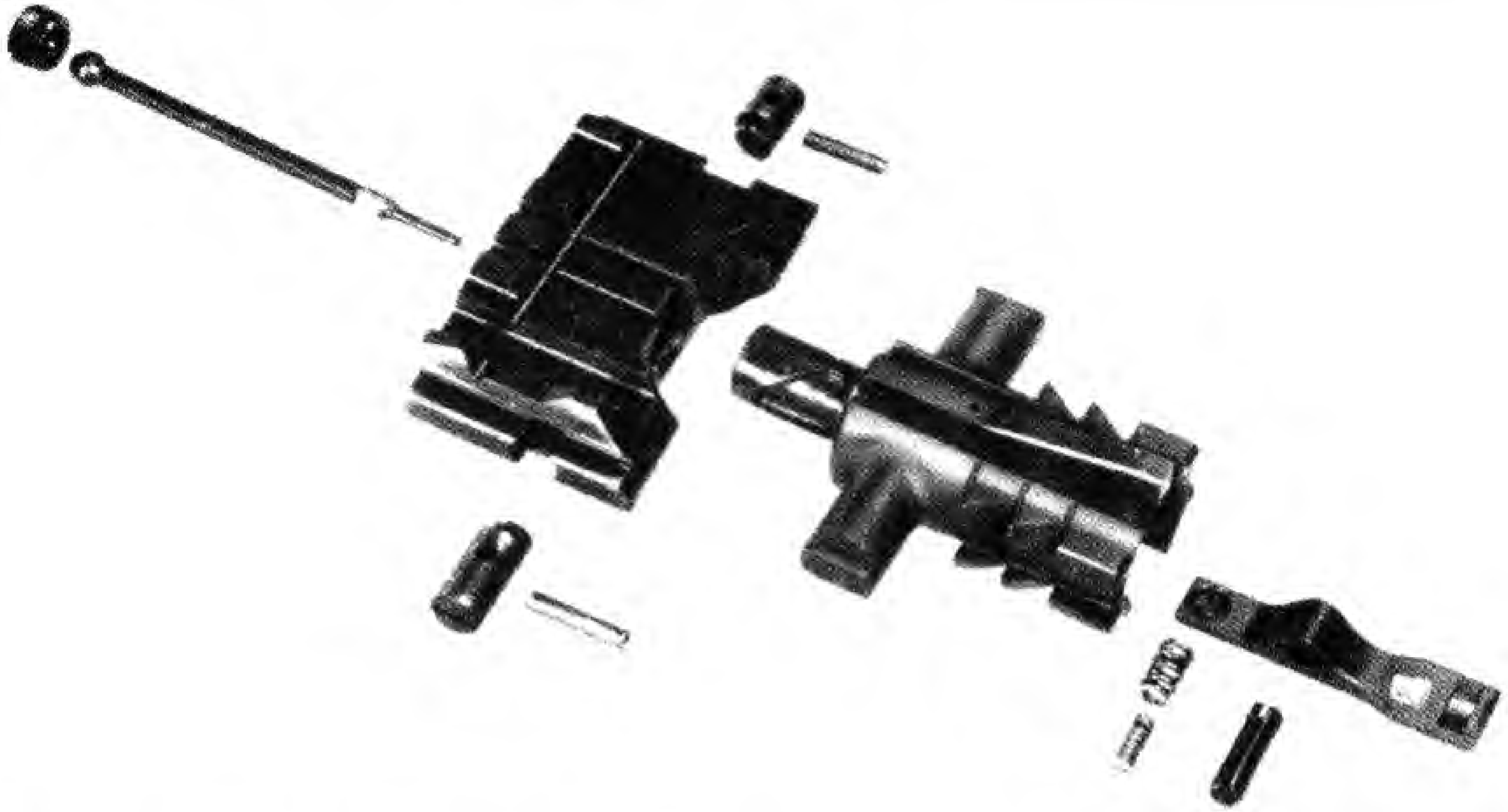
The T220E1 operates at the low rate of fire in the same way as at the high rate, except that the bolt group is held by a rear sear after each round is fired. When the bolt group strikes the buffer to return in counterrecoil, the sear stops it momentarily, and then, when the bolt group continues forward, it is driven only by the bolt-return spring, thus reducing the speed of counterrecoil. The momentary stopping of the bolt group and the reduced speed of counterrecoil decreases the rate of fire to the low rate.



20mm T220E1 Automatic Gun Cover, Opened



20mm T220E1 Automatic Gun Bolt Assembly



20mm T220E1 Automatic Gun Bolt Assembly, Disassembled

Test Results

Various test firings showed that the most serious deficiency of the T220E1 was the operation of the feed mechanism by the barrel. Test firings revealed that the motion of the barrel (feed pawls), and the motion of the bolt must be synchronized within very narrow limits to obtain positive feeding. These experiments also indicated that the time of barrel recoil and the counterrecoil cycle vary with changes in the belt pull, the rigidity of the mounting structure, the stiffness of the recoil mechanism, and the weight of the barrel. Since these variations upset the timing of the feed pawls and the positioning of the round, positive feeding could not be obtained under all firing or mounting conditions. For example, numerous failures to feed and many stubbed rounds occurred because the feed pawls either failed to engage the incoming round or held the round improperly, permitting the bolt to strike the round off-center or to miss the head of the cartridge case.

The rate of fire of the T220E1 was also lower than expected. When fired from a rigid mount equipped with a "stiff" ring-spring recoil mechanism (3,500 lbs/in) the rate was approximately 900 rounds per minute, when fired from the T189 and T190 mounts (1,200 lbs/in), the reported rates were approximately 860 rounds per minute. When equipped with the hydrospring recoil mechanism (500 lbs/in), the rate decreased to approximately 800 rounds per minute. From test results, it appeared that a major design change would be necessary before the expected rates could be attained with a modified recoil system.

The best 4,000 rounds of firing had a stoppage rate of 8 per 1,000. Further development would be required to improve the stoppage rate, belt pull and function of the low rate mechanism.

SECTION II.

20mm T247 SHORT RANGE ANTI-AIRCRAFT GUN

AMERICAN MACHINE & FOUNDRY

History

The T247 was an attempt to redesign the T220 while keeping the same basic rotating bolt locking mechanism.

In August 1956, work on the T247 gun was started at American Machine and Foundry to investigate what weight savings and overall weapon simplifications could be achieved assuming the dual rate could be effected simply by changing the timing of the bolt unlocking, which always operated by short recoil. Preliminary firings at Springfield Armory indicated that this might be possible since cyclic rates below 600 rounds per minute had been obtained with the modified short recoil mode with the T220 weapon when it was first test fired.

Greater freedom of feeder and ejection mechanism design was achieved by eliminating the long recoil mode of operation. The barrel grooves required by the low rate system in the T220 were eliminated as well as other parts such as the low rate barrel return spring.

The primary difficulty with the T247 was its complex feed system which never operated satisfactorily. A second version of the T247 was built with minor modifications to operation, cycle and detail parts. However, neither prototype was considered successful, and the program was terminated in October 1957.

The guns were built by Mathewson Tool Company.

Description and Purpose

The first version of the T247 Gun, was a T220 weapon having the following major differences:

1. It was designed to operate at both the high and low rates on the short recoil principle.

2. The feeder drive was transmitted from the recoiling barrel to the slides by means of a bell crank instead of a cam tube and arm.

3. Rate change was made by moving the bolt unlock cams.

4. The bolt buffer was designed into the bolt body, instead of in the back plate.

5. Ejection was accomplished by means of a stationary lug in the receiver instead of a spring pin in the bolt to increase ejection velocity.

Cycle of Operation

After a round was fired at the low rate, the barrel group and the locked bolt group recoiled about 10 inches. The bolt body was held by a sear when the barrel group struck the recoil buffer. On counterrecoil, an internal cam between the bolt body and the bolt head rotated the latter to unlock it from the barrel group. As the barrel group returned to battery, it released the sear, allowing the bolt to chamber and fire another cartridge. A claw at the bottom of the bolt head extracted the empty cartridges. An axial spring-loaded pin in the bolt head pressed against the top of the rim of the cartridge, which then pivoted about the extractor and tumbled out the bottom of the receiver as soon as the front of the case cleared the barrel extension. The T220 used energy from the barrel group, not from the bolt (as in the T173), to actuate the feeding mechanism. The feeding cam and linkages functioned in the same way regardless of the rate of fire, and the gun employed the T51 link. The operation of the T220 when fired at the high rate of fire was similar to that of the T173.

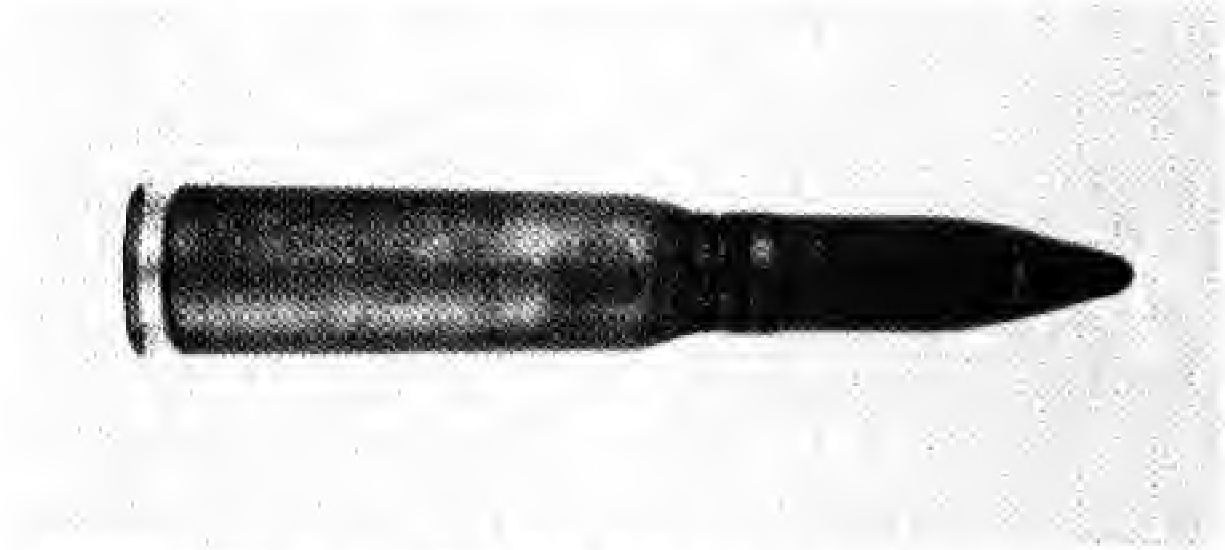
Test Results

The operation of the T247 Gun was unusually complicated because of the complex linkages be-

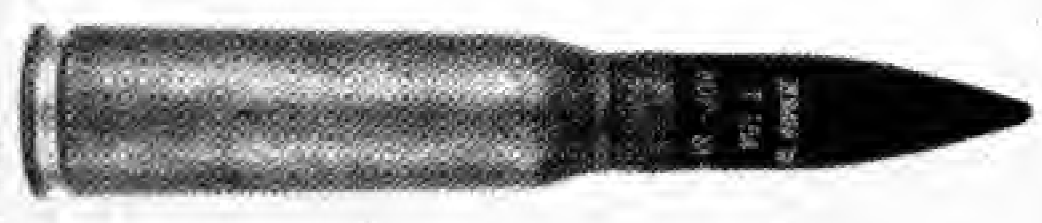
Characteristics

Weight of Gun (complete)	102 lb.
Weight of Barrel including Flash Suppressor	27.5 lb.
Overall Length of Gun	95.13 in.
Overall Length of Barrel	60 in.
Overall Width of Gun	7.19 in.
Overall Height of Gun	6.88 in.
Rate of Fire, High	1100 + 100 rpm
Low	500 + 100 rpm

tween the barrel and the feed pawls and between the bolt and the primary rammer. These linkages and the weak driving springs were the prime factors contributing to its extremely low rate of fire. Excessive breakages and many failures to feed occurred during the limited firings. Since the gun appeared unduly complex and since its development was lagging, the T247 Gun was considered to be the least satisfactory of the T220 series weapons. Development of this weapon was curtailed in October 1957.



20mm M50 Series (T154) U.S. Electric-Primed Ammunition (Photo courtesy of Woodin Laboratories).

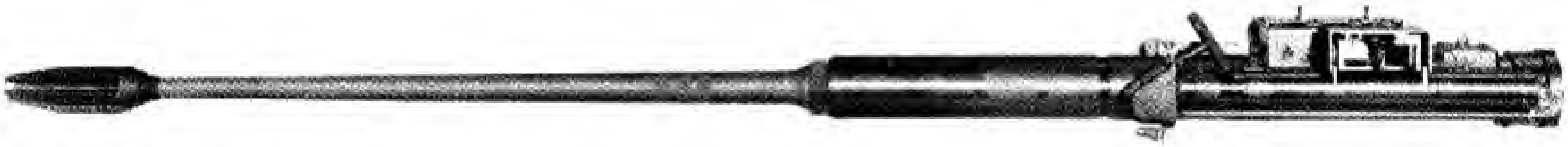


Pictured here is an early one (T154) circa 1952 (Photo courtesy of Woodin Laboratories).

SECTION III.

20mm T220E2 SHORT RANGE ANTI-AIRCRAFT GUN

DIXON RESEARCH



20mm Short Range Anti-Aircraft T220E2

History

In May 1957, Dixon Research, developer of the T173 calibre .60 automatic gun, began work on a 20mm weapon to compete with the T220E1. The new model, designated the T220E2 had a dual-position sear and an improved charger. The recoiling bolt, instead of the recoiling barrel group as in the T220E1, supplied the energy to operate the feeding mechanism of the T220E2. The T220E2 weapon was a direct descendant of the T173 gun and its construction was similar to the 37mm T37 gun.

The T220E2 was generally considered the best of the series. Each was recoil operated, had a rotating bolt locking system and fired percussion-primed ammunition. The T220E2 differed from the other three in that it used the motion of the bolt to drive the feed mechanism. This resulted in a much more positive system and eliminated most of the synchronization problems associated with the earlier weapons of the series. Two T220E2 guns were fabricated.

In 1961 Ordnance Tank Automotive Command and Ordnance Weapons Command recommended the T220E2 as a contender for the Vehicle Rapid Fire Weapon Interim System. The HS 820 was selected because it was in production. During Confirmatory Tests the HS 820 ran into trouble and the T220E2

20mm Short Range Anti-Aircraft T220E2

assets were retained as a backup in case the HS 820 problems could not be resolved.

Interest in the T220E2 was revived later in the 1960s when some project managers said they were having difficulty with the size and weight predicted for the Vehicle Rapid Fire Weapon System-Successor. As a result, four U.S. companies borrowed T220E2 material and used them in studies aimed at a lightweight weapon system suitable for vehicles such as the Scout.

Description and Purpose

The T220E2 is recoil operated, has a rotating bolt locking system and fires percussion-primed M150 series ammunition. The feeding mechanism is operated directly by the bolt and incorporates the feeder improvements developed during the extensive experimental testing of the earlier T17 series of calibre .60 and 20mm weapons.

The design for the T220E2 resulted from the need for a lightweight short-range antiaircraft system. The system was to be capable of being broken down into man-portable pieces and be effective against low flying aircraft with speeds to 800 mph, at 1,000 feet maximum altitude and 2,000 years maximum range. This was done for Project Octopus.

The gun, with 60 inch barrel, without soft mount or flash hider, was 75.6 inches long, 7 inches wide over the feed tray, and 6.5 inches high. The gun weighed 99.5 pounds and the barrel about 23 pounds. The belt entered the feed tray on the right side. Cases were ejected rim first, downward and backward, at an angle of about 20 degrees to the gun axis, without tumbling. Thus a radiused deflector could turn the cases to deliver them forward or to either side, well out of the working area of the gun mount. The links were ejected on the left side.

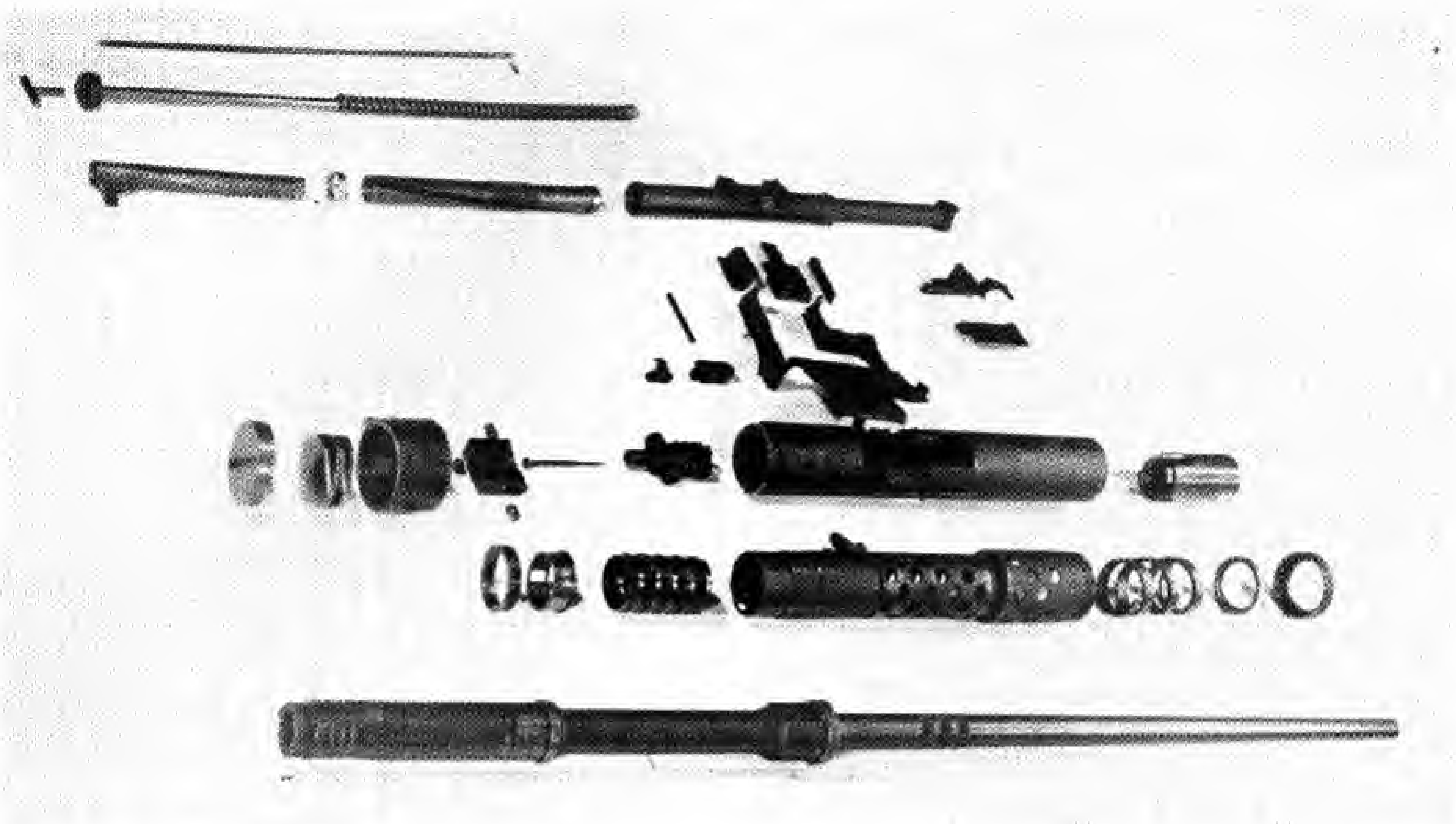
The gun fired the 1,800 grain 20mm projectile from an expanded calibre .60 case. Its rate of fire on a hard mount was about 1,275 rpm with a soft mount, 1,100 rpm. The soft mount was necessary in service because of the severe trunnion reactions. Its rate of fire with a single barrel and hot round limited a continuous burst to 35 rounds so it had a quick change barrel. The interrupted thread of the barrel screwed into the barrel extension which included the locking lugs for the bolt, the starting cam for bolt locking and formed a part of the feed throat. The charging mechanism was a cable inside of the bolt drive spring. It had a 2:1 ratio, so the charging effort varied from 40 to 70 lbs. over a stroke of 16 inches.

Cycle of Operation

The barrel extension was restrained in recoil by a 600 lb. coil spring and in counterrecoil by a ring spring package. The bolt was carried by a bolt body and by its trunnions running in grooves in the receiver. The bolt body ran in the same grooves. A cam at the front of the bolt body cooperated with the starting cam in the barrel extension to rotate the bolt head 23 degrees into the locks. After 3/8 inches of barrel recoil the bolt head trunnions contacted unlocking cams in the receiver which both unlocked the bolt and acting through the bolt body unlocking cams accelerated the bolt body which then snatched the bolt head out of the locks. A cotter on the sleeve

Characteristics

GUN:	
Weight of Gun (complete)	99.5 lb.
Weight of Barrel including Flash Suppressor	23 lb.
Overall Length of Barrel	60 in.
Overall Width of Gun	7 in.
Overall Height of Gun	6.5 in.
Rate of Fire	1275 rpm



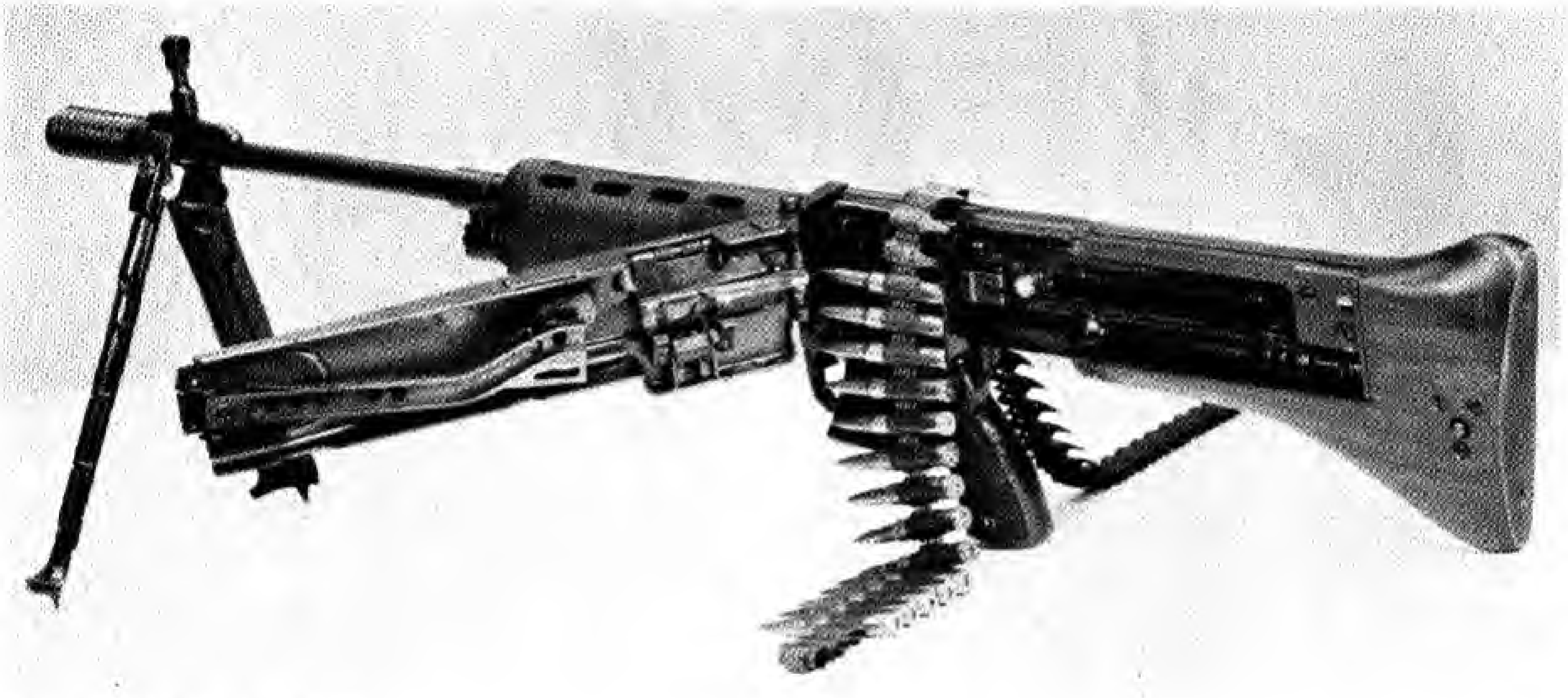
Disassembly of 20mm T220E2

surrounding the bolt drive spring engaged the bolt body through a helical slot in the feed cam and through a slot in the receiver. The bolt drive spring urged the bolt toward battery with a force decreasing from 140 to 80 lbs. As the bolt recoiled it rotated the feed cam which moved a fresh round into the feed tray through a pair of feed pawls acting on the link. A pair of strippers separated the link from the round. The skirts of the link acted as the upper guide for the round as it was being chambered. When the bolt in recoil had cleared the round in the feed tray by 1/2 inch, it contacted the bolt buffer spring which it compressed 5/16 inch. This spring consisted of four curved diamond shaped elements. As the bolt came off of the buffer spring, if firing was to be interrupted, a sear with a roller tip swung down to engage its roller with a pocket on the bolt body. When firing was resumed, pulling the trigger would roll the sear off of the bolt body allowing it to chamber a round. The forward movement of the bolt would carry a round into the chamber and through the feed tube would carry the belt through another pair of feed pawls into a partially stripped position in the feed tray.

Chapter 25

7.62mm M60 MACHINE GUN

MAREMONT CORPORATION



7.62mm M60 Machine Gun

History

The M60 machine gun, originally designated T-161E3, is the result of a series of designs started near the end of World War II at Springfield Armory. The first of these was called the T44 and was essentially a combination of the belt feed mechanism of the German MG42 with the operating mechanism, rotating bolt, of the FG42 automatic rifle. In turn, certain features of the FG42 were taken from the US designed Lewis Gun used in World War I. A less extensively modified version of the T44 was the T52, from which evolved the T161 series after the wooden stocks were replaced with plastic. The first version of this series was in calibre .30. The T161E2 adapted the design to the improved calibre .30 cartridge (T65E3) and the T161E3 used the NATO 7.62mm cartridge. This final version was put into production as the M60.

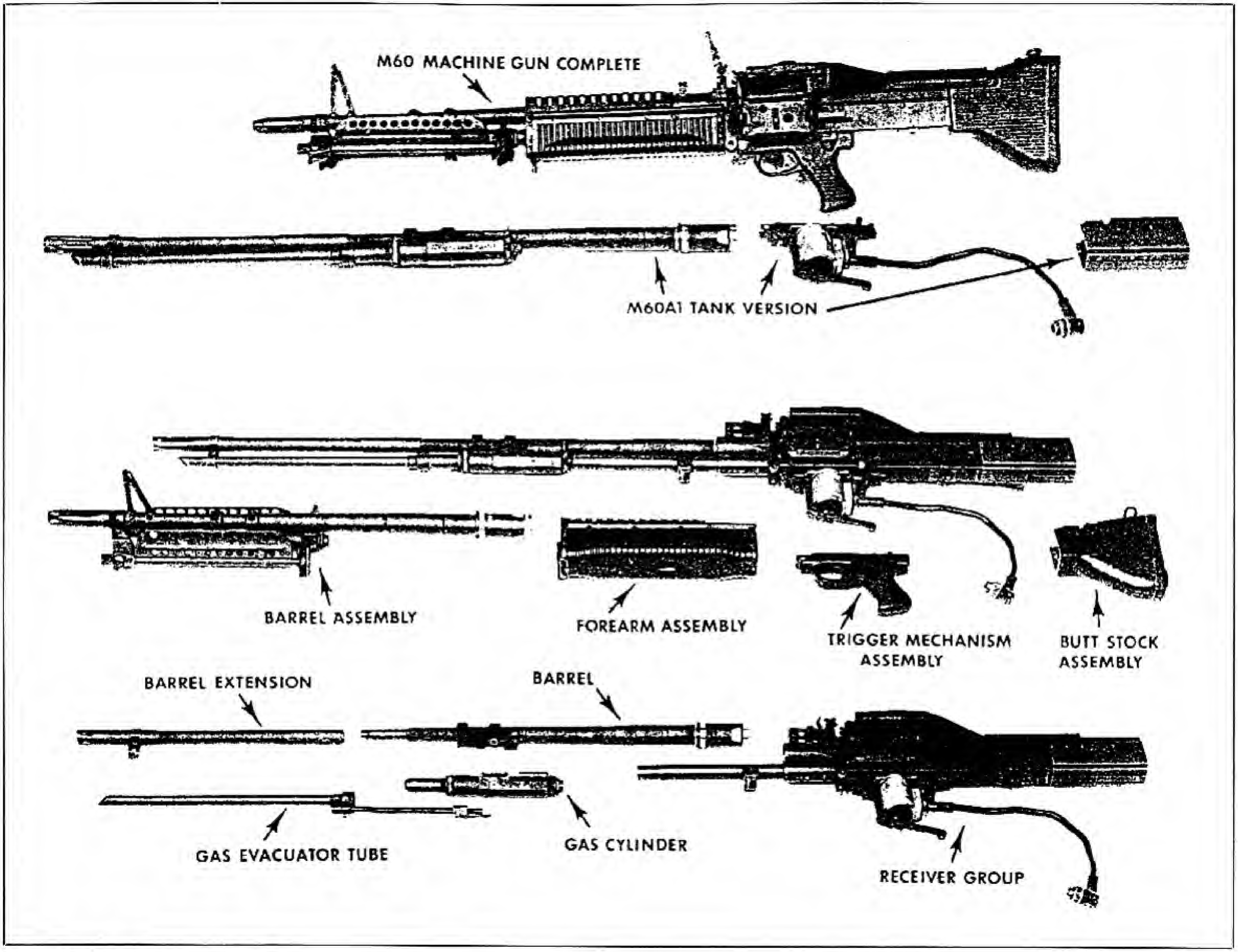
The M60 has been modified since original manufacture. The receiver has been strengthened by the addition of several pins and the feed tray now has a hanger assembly pinned to it.

A modified version of the M60 machine gun, the M60E1, has been developed. The principal reason for the development is to simplify barrel change and decrease the number of parts.

Continuing since 1967, Maremont Corporations has been modifying the M60 model machine gun for tank use. The M60E2 offers the armed forces an alternate 7.62mm tank machine gun to the M37 or M219 types.

Description and Purpose

The 7.62mm M60 machine gun is a lightweight,


M60 MACHINE GUN COMPLETE
M60A1 TANK VERSION
BARREL ASSEMBLY
FOREARM ASSEMBLY
TRIGGER MECHANISM ASSEMBLY
BUTT STOCK ASSEMBLY
BARREL EXTENSION
BARREL
GAS EVACUATOR TUBE
GAS CYLINDER
RECEIVER GROUP

Assembly Groups

Characteristics

Calibre	7.62mm (Nato)
Rate of Fire (Maximum)	550 rpm (approx.) Sustained: 100 rpm
Muzzle Velocity	2800 fps approx.
Weight	23.2 lbs.
Length	43.50 in.
Chamber Pressure	52,000 psi.
Maximum Range	4100 Yards
Maximum Effective Range	1200 yards
Flat Trajectory	
Gas Operated	

gas operated, air cooled, link-belt fed general purpose machine gun designed to replace all existing calibre .30 ground mounted machine guns. It is designed to fire the NATO standard 7.62mm cartridge using the same cartridge-link combination used with the M73 machine gun, and is capable of being fired from either the hip, shoulder, or on the ground using its integral bipod for the direct fire role and the M122 tripod mount for the prearranged fire role.

The M60 is called a general purpose gun because it replaces the calibre .30 Browning light machine gun. The M60 is the first United States machine gun to have a true quick-change barrel. It was specifically designed to be lightweight, and its components design was simplified for manufacture. Stampings or fabrications were used wherever possible. The quick-change barrel, lightweight, and adaptability for use as either a heavy or light machine gun, as well as relative ease of manufacture, make the M60 a superior gun.

Cycle of Operation

With the gun loaded, in the cocked position, the following is the cycle of operation:

Pulling the trigger raises the front of the sear, dropping the rear of the sear out of its engagement notch in the operating rod.

The operating rod, released by the sear, is propelled forward by the energy stored in the drive spring by the cocking operation. The bolt, engaged by the operating rod cam yoke is carried forward with the rod, as is the gas piston, should it be positioned to the rear.

The bolt top locking lug strikes the rear edge of cartridge in the feed plate groove, where the cartridge is positioned by the belt link and the feed cover guides and springs. The bolt strips the cartridge from its link, carrying the cartridge forward out of the feed plate. The empty link is retained in the feed plate by the cartridge guide and the next round.

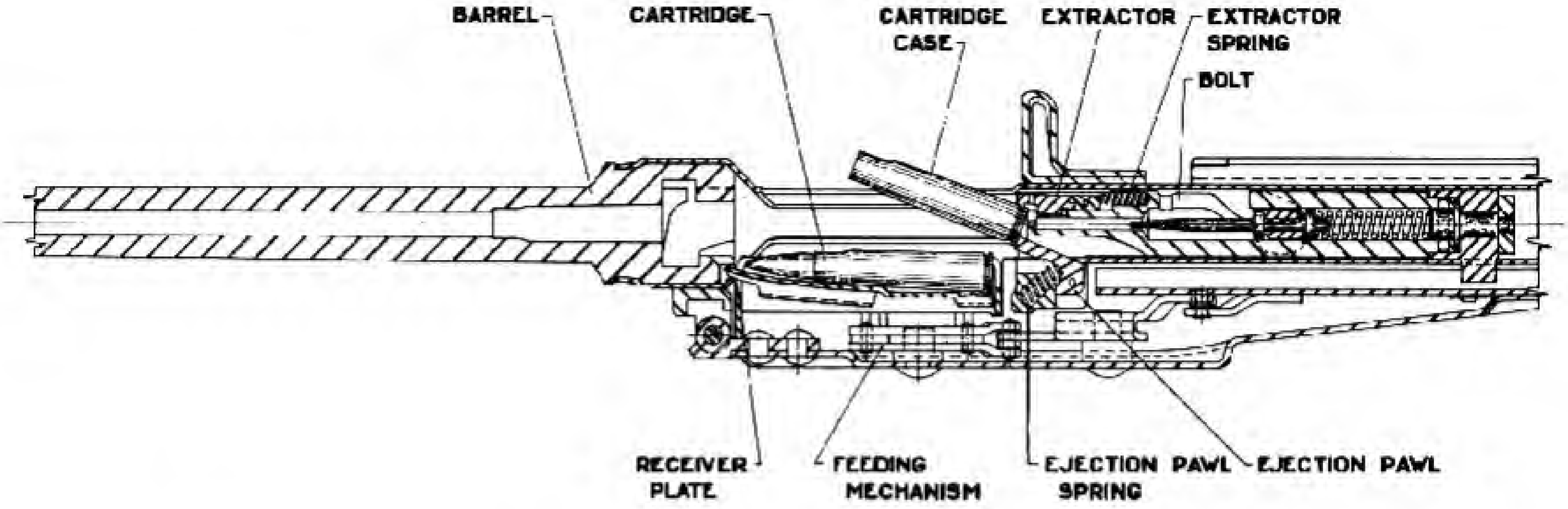
As the bolt enters the barrel socket, the round has been deflected downward and into the chamber by the front cartridge guide, the receiver feed ramps, and the barrel socket feed ramp. The barrel socket lead cams impart clockwise rotation to the bolt sufficient to enter the locking lugs into the socket locking cam. At this point the round is seated in the chamber, its base contacting the extractor and ejector. The forward motion of the operating rod and bolt compresses the ejector spring, and moves the extractor out to snap over the rim of the cartridge.

The firing pin, held back by the bolt cam and its engagement with the operating rod, has also compressed its drive spring during cocking. As the bolt rotates, its rotating cam releases the firing pin. The firing pin spring now contributes its energy to the operating rod through the bolt rotating cam and aids the drive spring to complete the bolt locking rotation. The operating rod continues forward, carrying the firing pin with it until the pin strikes the cartridge primer and ignites it. The firing pin is stopped by its seat in the bolt at the pin front bearing spool, stopping the operating rod. The operating rod has also positioned the piston in its forward position.

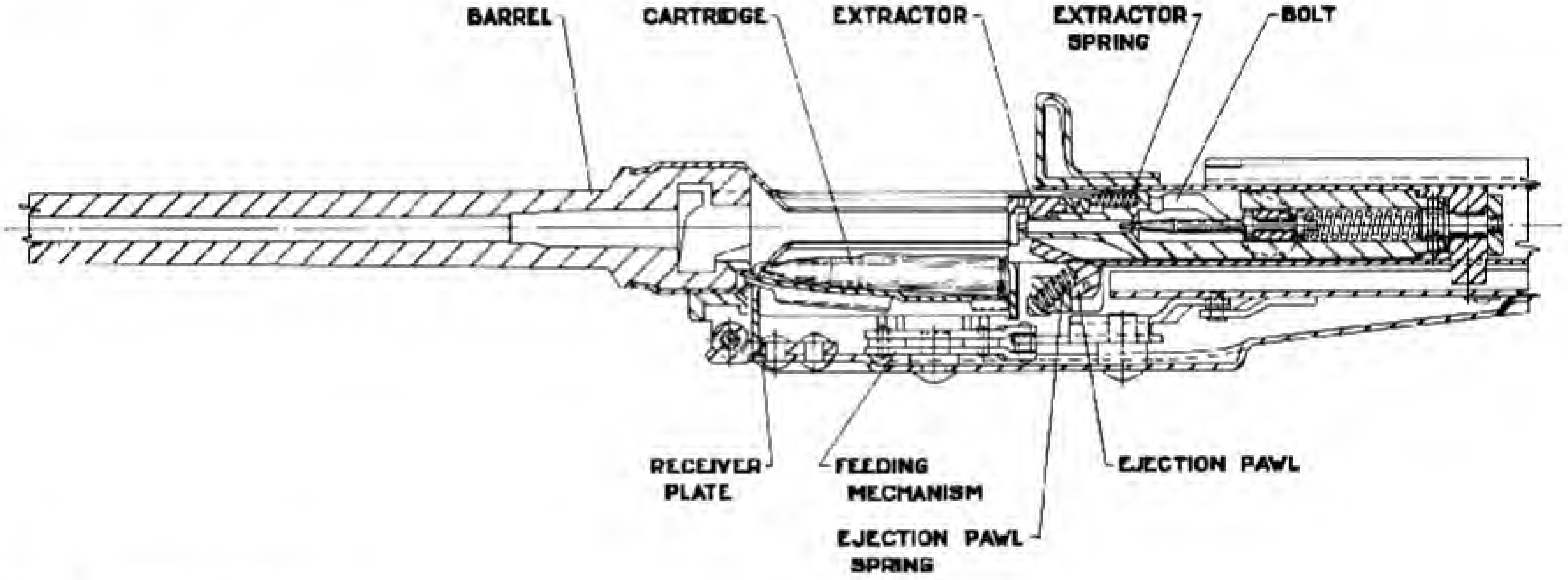
After ignition of the powder charge by the primer, the bullet is forced down the bore by the gases released. At a point about 8 inches from the muzzle, the bullet passes the barrel gas port, allowing part of the gases under pressure to enter the gas cylinder and hollow piston through their respective ports, which are aligned with the barrel port.

Gas under pressure, bled from the bore by the gas port, fills the hollow piston until enough pressure is built up to overcome the mass of the piston and operating rod and the load of the operating rod spring. The piston begins its travel rearward, propelled by gas pressure against the forward end of the cylinder. After a very short travel rearward, the piston ports and collector ring are out of line with the barrel gas port, sealing off a measured charge of gas under pressure in the cylinder and hollow piston. By this time, the bullet is well out of the bore, and gas pressure in the bore rapidly falls to help provide easy extraction of the spent round.

The piston, propelled rearward by the trapped expanding hot gases, forces the operating rod rear-


BARREL
CARTRIDGE
CARTRIDGE CASE
EXTRACTOR
EXTRACTOR SPRING
BOLT
RECEIVER PLATE
FEEDING MECHANISM
EJECTION PAWL SPRING
EJECTION PAWL

Cartridge Being Ejected


BARREL
CARTRIDGE
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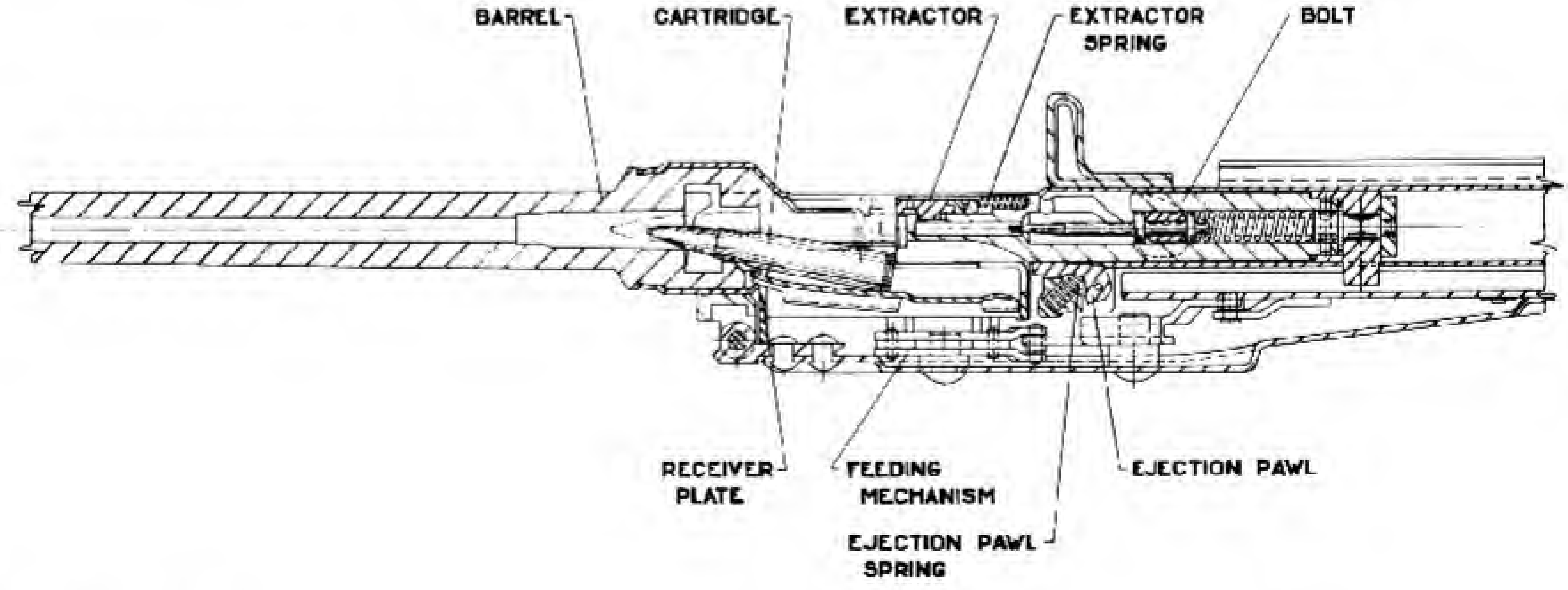
BOLT
RECEIVER PLATE
FEEDING MECHANISM
EJECTION PAWL
EJECTION PAWL SPRING

Bolt in Ramming Position


BARREL
CARTRIDGE
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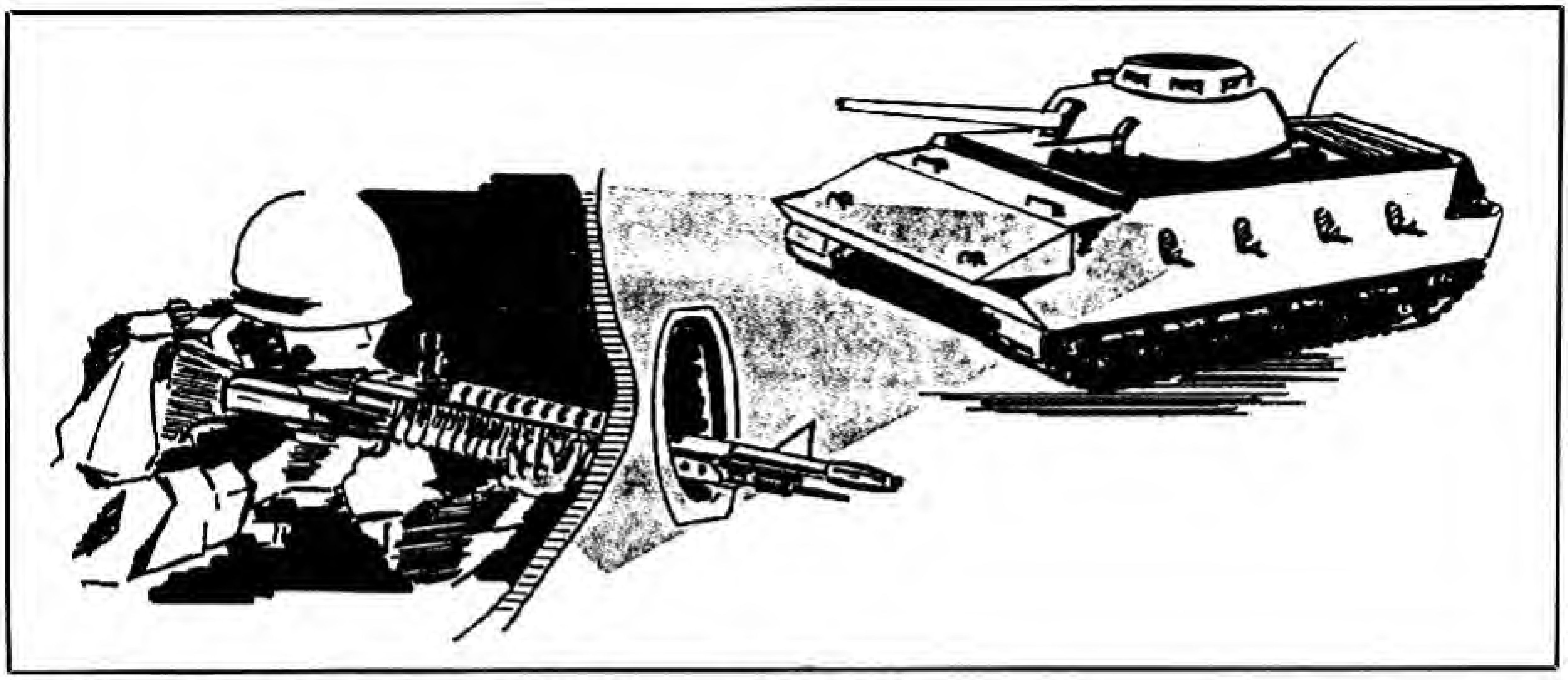
EJECTION PAWL
EJECTION PAWL SPRING

During Ramming

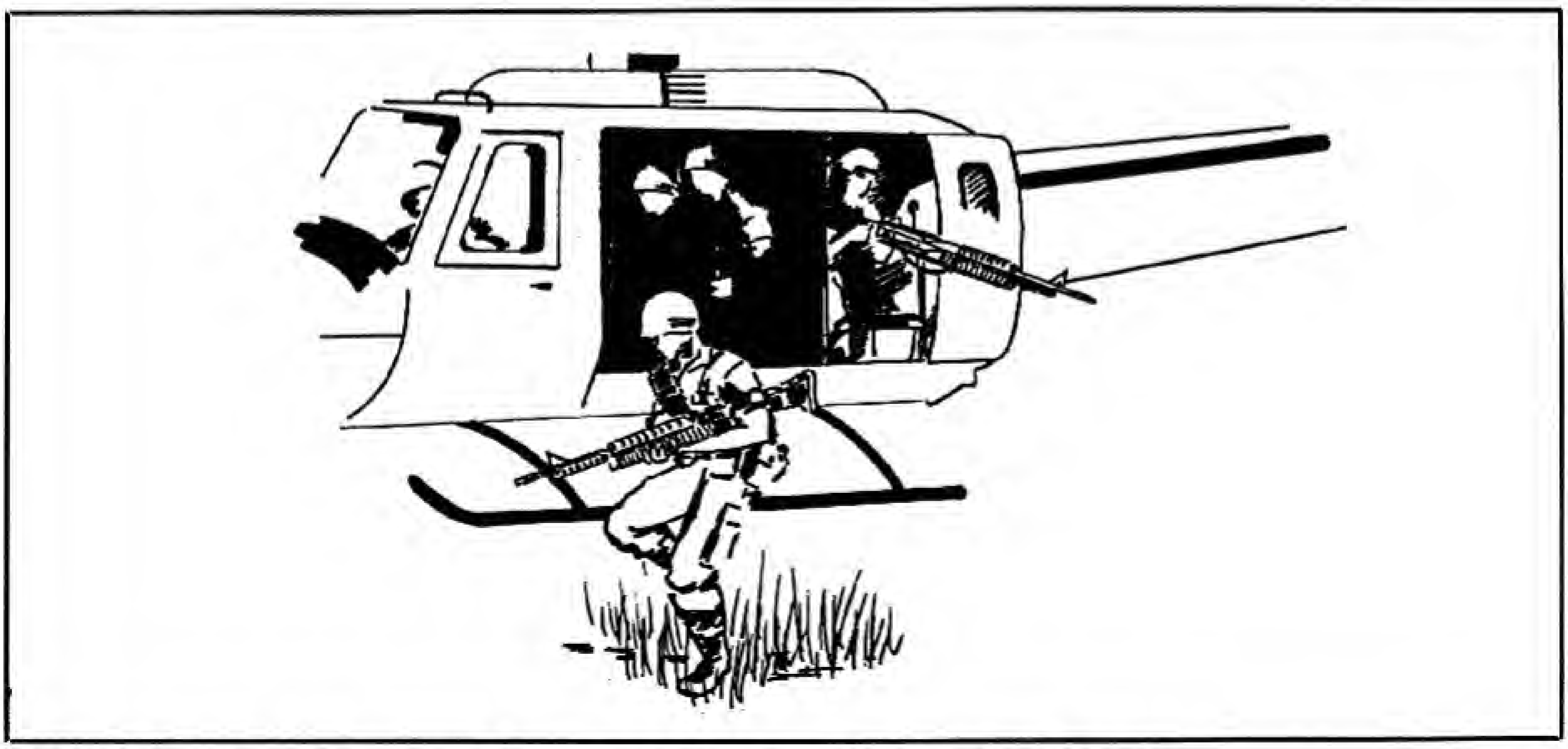


For Personnel Carrier Employment a Short Gas Evacuator Tube is used.

ward to contact the firing pin rear spool. This compresses the firing pin spring withdrawing the firing pin from the cartridge primer as well as compressing the operating rod spring. Rearward motion of the operating rod continues in the "dwell" slot of the bolt rotating cam, until the rod yoke rollers contact the spiral, or counterrotating part of the bolt cam.

The bolt now begins its counterclockwise rotation and unlocking, urged by the energy of the operating rod. At full unlock, the firing pin spring is fully cocked, the roller of the rod cam yoke contacting the rear of the bolt rotating cam.

Bolt and rod together continue to the rear, propelled by the energy of the expanding gas, withdrawing the spent cartridge from the barrel chamber. As the spent cartridge leaves the chamber it is moved sideward in the direction of the ejection port, the ejector spins the case sideward to pivot about the extractor lip and disengage, allowing the case to be ejected with force out of the port, and against the



The M60 Machine Gun as a Personnel Weapon and a Waist Gun, "D" Version for a Helicopter.

ejection deflector which propels it downward.

In this interval, the piston has reached the limit of its travel. Spent gases are exhausted through ports provided in the gas cylinder, uncovered by the piston in its rearward travel.

Air behind the piston is exhausted through a set of ports near the rear of the gas cylinder, allowing escape of dirt and powder residue.

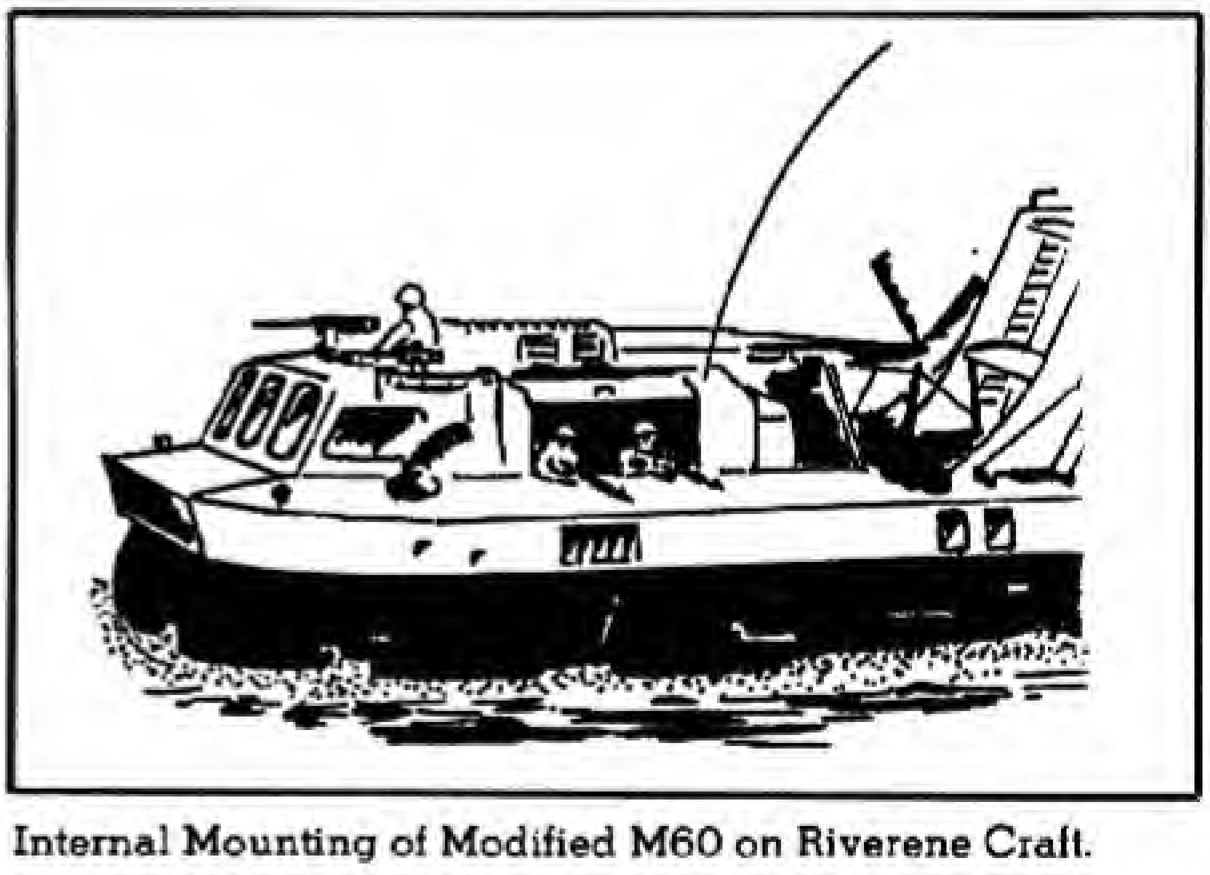
The bolt and operating rod continue rearward, propelled by stored energy and inertia, compressing the operating rod drive spring. As the drive spring is fully compressed, the operating rod contacts the buffer through the drive spring guide rod collar. Energy remaining in the rod and bolt is now transferred to the buffer. As the buffer plunger is forced rearward against its pads and preloaded springs, the rubber pads are compressed, acting as a high-rate spring. The rubber is forced to flow radially, to expand frictional surfaces tight against the buffer tube wall. Further rearward motion compresses the buffer return spring and the sliding friction of the pads on the tube wall absorbs the remaining energy of the rod and bolt. The moving parts now come to rest, and the counterrecoil cycle begins.

The energy stored in the drive spring now forces the operating rod and bolt forward. The frictionally damped buffer springs return the buffer plunger to its initial position. The firing pin spring also contributes some force until it is halted by the front of the rod yoke, which stops the firing pin in the "cocked" position in the bolt rotating cam. As the rod continues forward with the bolt, if the trigger has been released, the sear is held up against the bottom of the rod by the sear spring. As the sear engages the sear notch in the rod, forward motion stops, and the weapon is held in cocked position, ready for fire. If the trigger has not been released, the weapon continues to fire until interrupted by the sear, or until the ammunition is exhausted. If the last round is fired and the trigger held down, the gun will close on any empty chamber, and must be recocked manually.

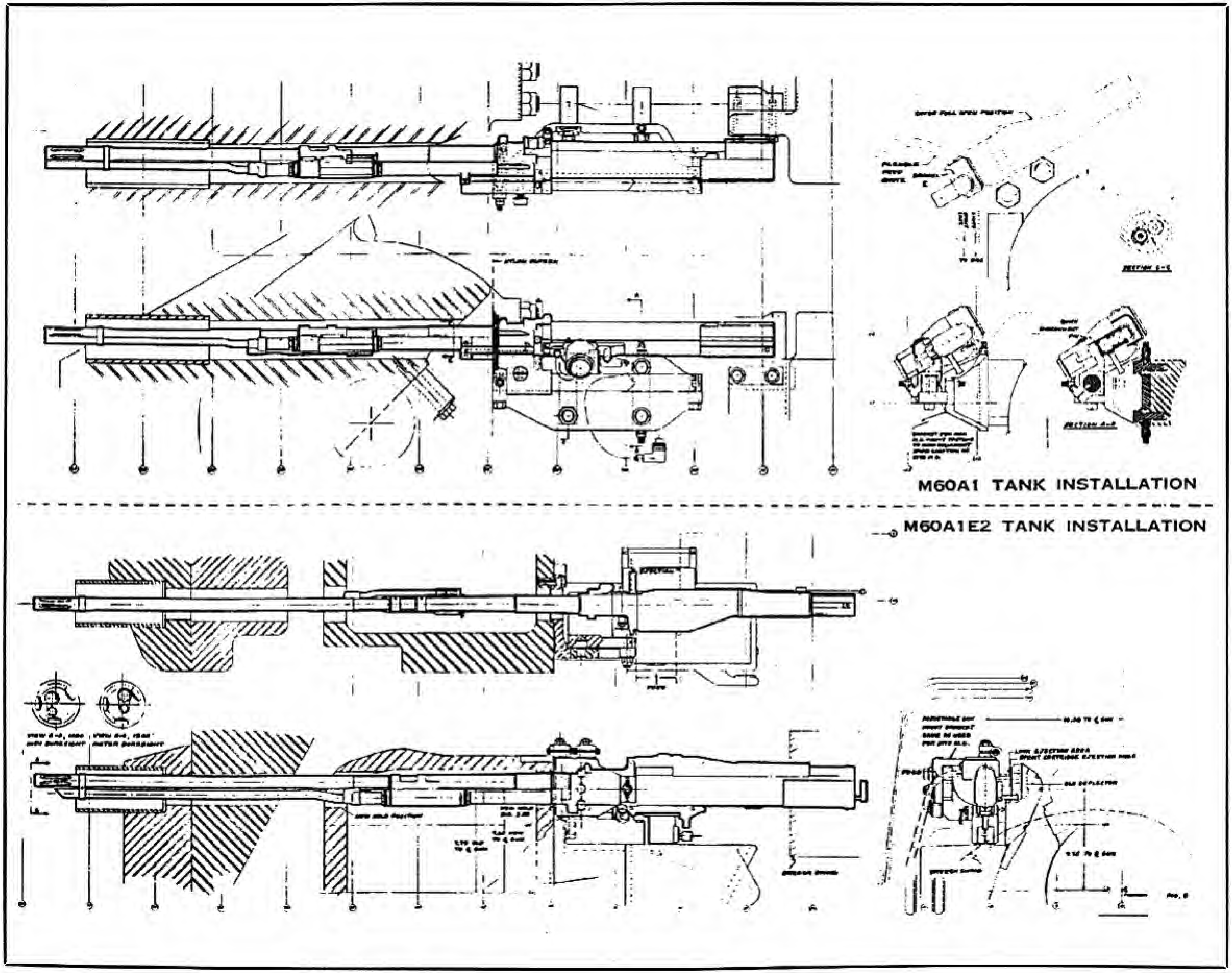
Feed Cycle. For simplification of description, this portion of the operation is considered separately.

As the bolt travels forward for firing, the feed cam mounted in the feed cover is engaged by the feed cam actuator roller attached to the rear of the bolt. Forward motion of the bolt and actuator causes the feed cam to swing to the right, forcing the front of the feed cam lever to the left. This carries the cartridge feed pawl plate assembly to the left where the pawls drop over and engage the next or second round for transport, and remain there until the round in the plate is stripped and fired.

As the bolt recoils, the actuator forces the feed cam to the left, and the feed pawl assembly transports the round to the right into the feed plate groove. The round is forced down into the groove by the cartridge guides and their springs. The empty link left on the plate is pushed out the port in the feed plate by the new round as it is fed. The feed plate contains a spring-loaded retaining pawl that retains the belt, holding the second round when the first round is in the plate groove. Two anti-friction rollers help guide the belt in place, and support the hanging belt. The weapon is provided with sufficient reserve power to lift a 100-round belt vertically under all normal operating conditions.



Internal Mounting of Modified M60 on Riverene Craft.


M60A1 TANK INSTALLATION
M60A1E2 TANK INSTALLATION
SECTION C-C
SECTION A-A

SECTION I.

7.62mm M60E2 MACHINE GUN

Continuing since 1967, Maremont has conducted an in-house program to provide a modified M60 machine gun that would be suitable for service in tank and other enclosed vehicular installations. The M60E2 offers the armed forces an alternate 7.62mm tank machine gun to the M37 or M219 types.

The main features of the M60E2 machine gun are a gas exhaust system that collects the spent gas from around the gas cylinder group and directs it forward to the muzzle area and a barrel extension which carries the muzzle gases forward, and away from the gunners' compartment. An obturating type gas cylinder nut and an auxiliary collar on the operating rod effectively restrict the gases from reaching the receiver area. Other features of the M60E2 include the ability to convert a standard infantry M60 for tank installations by removing the forestock, buttstock, pistol grip, rear sight, and charging handle. These items are replaced with a M60C type buttstock cover, a firing solenoid assembly with manual trigger, a mount adapter bracket, and a redesigned charging handle. The regular barrel assembly is replaced with an assembly which includes a barrel extension and gas evacuator system. Performance of the modified gun is similar to the basic M60.

The M60E2 machine gun is readily available in quantity and components required for its modification can be easily put into production. Supply of spare parts would not be a problem, as all major components of the M60E2 are interchangeable with standard replacement M60 components. Training and maintenance would also be simplified, as the user is well indoctrinated in the use of the M60 machine gun. M60E2 maintenance is inherently simpler than M37 or M219 type tank machine guns.

System Description

The M60E2 machine gun for tank use is basically an M60C model with a barrel extension and a gas evacuator system. The large inside diameter of the barrel extension, approximately two and one-half times the 7.62mm bore, allows the gases to expand and be directed to the outside of the vehicles compartment. The extension is screwed onto the barrel using the same threads as the flash suppressor. The flash suppressor is then incorporated onto the outer end of the extension. Barrel extension length is regulated by the particular installation: on the M60E1 the extension is about 13" long; and consists of an additional tube alongside the barrel and barrel extension which carries the gases from the gas cylinder to the outside of the tank. The connection of this extra tube to the gas cylinder requires a new cylinder to accommodate it; however, the barrel remains the same.

In the original modified M60 design, there was a two piece gas cylinder assembly which could be separated from the barrel by turning the cylinder 90° from the barrel after releasing the lock. This whole assembly is completely interchangeable with a standard M60 barrel assembly. Each time a barrel is changed, the gas cylinder assembly, being quickly removed, could have been rapidly interchanged from one barrel to another. This was the basic approach of the M60E1 machine gun, however, in the original design, the kinematic operation of the weapon was not altered, since the standard gas piston and stroke was retained together with the "White Principle" gas expansion system. Provisions were made on the gas cylinder for mounting a bipod for field use.

The gas port has been relocated to offer a smaller cylinder profile and to allow the incorporating of a power selector valve if desired. The gas cylinder in the final design cannot be separated from the barrel as it could in the earlier version since Maremont felt that the entire barrel assembly would probably be changed in combat situations because of tactical timing considerations. The one piece cylinder version also allows complete interchangeability of parts with the standard M60 gun. Preliminary studies also indicate that the one piece cylinder will be lower in unit cost than the earlier design.

It has been established by tests that the basic M60 performance characteristics of the modified weapon remain relatively unchanged. Muzzle velocity, approximately 2800 fps, increases slightly with the barrel extension, however, the rate of fire, approximately 550 rpm, remains within the acceptable limits. Tests were conducted with the same weapon interchanging the new barrel and tube assembly with a standard barrel assembly.

A mechanism is provided for manually triggering the gun if there is a solenoid or electrical failure. This mechanism becomes a part of the complete trigger assembly. The sear housing is also fitted with a fire-safe selector. The charging handle is re-designed to be suitable for use in all fixed-mount installations.

Characteristics

Rate of Fire	550 rpm
Muzzle Velocity	2800 fps
Weight	24 lbs.
Length (basic)	43.5 in.
Chamber Pressure	52,000 psi

SECTION II.

7.62mm XM7 HELICOPTER ARMAMENT SUBSYSTEM

General

XM7 is generic nomenclature for a lightweight, simply attached helicopter gun system which mounted two 7.62mm M60 machine guns. The concept was a part of the original U.S. Army Scout Helicopter program, and the competing contractors (Hughes, Bell and Hiller) each provided an XM7 system for evaluation with their respective helicopters. Following award of the OH-6A Scout helicopter program to Hughes, further efforts with the XM7 were curtailed in favor of the XM27E1 (Minigun) helicopter armament kit which later incorporated most of the features of Hughes XM7.

Description

The Hughes XM7 system mounted two inverted M60C machine guns which were stripped of their bipods, forearm assemblies and butt stocks. Further, the trigger group was replaced with a solenoid for remote firing and an electrical actuator was added for in-flight charging/clearing purposes. The system included a quickly detachable ammunition box containing 1500 rounds of linked ammunition. The system was flexible in elevation only, fired at a rate of 1200 spm, and was equipped with an optional aerodynamic fairing (pod).

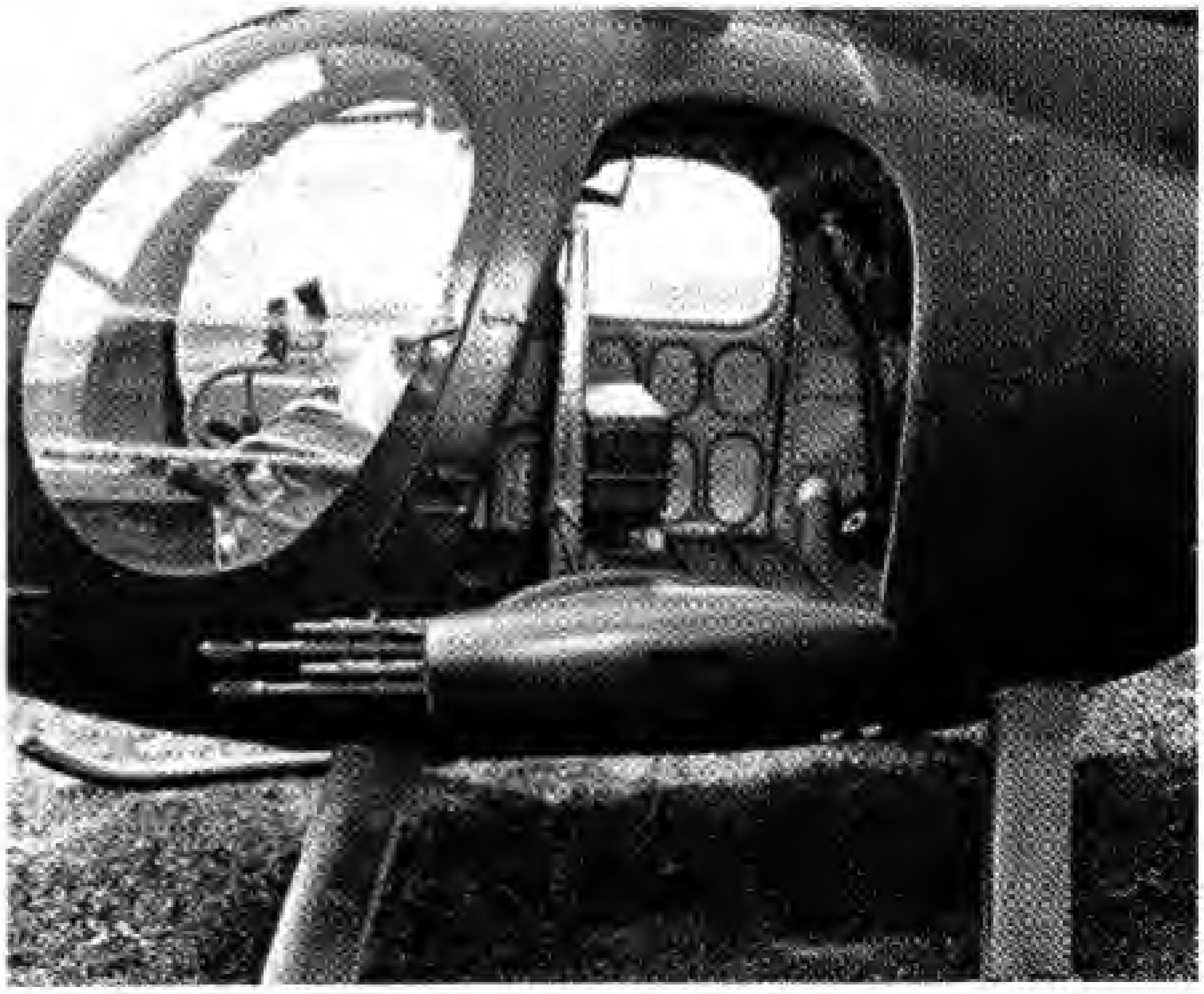
Characteristics

ARMAMENT SUBSYSTEM:	
Weight (without ammunition)	109 lbs.
Weight (with ammunition)	204 lbs.
Ammunition Capacity	1500 rounds
Elevation Limits	+10°, -24°
Operating Voltage	24 vdc
MACHINE GUN, 7.62mm, M60C:	
Number of Weapons	2
Rate of Fire (each)	600 spm
Weight (each, as modified)	25 lbs.
Muzzle Velocity	2800 fps
Method of Operation	Gas
Links	M13
Ammunition	7.62mm (NATO)

Contract History

As previously noted, the Hughes XM7 was generated as a part of the Scout Helicopter competition with no subsequent development funding. The weapon system, however, was fully ground and flight tested and is readily adaptable to such weapons as the MAG-58 (Netherlands) and M62 (Japan), in addition to the U.S. M60.

Features from the XM27E1, a 2000 round ammunition box, and the XM70E1 reflex sight, to name a few, may be simply incorporated in the existent data package to suit customer requirements.



7.62mm XM7 Armament Subsystem Helicopter

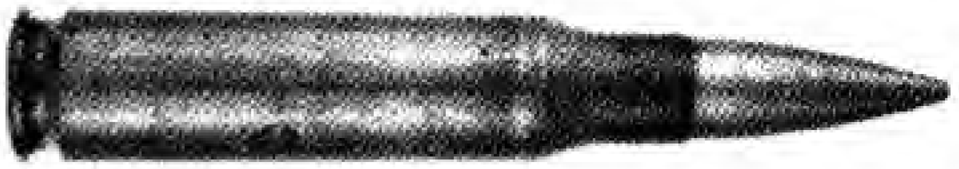
Ammunition

The ammunition for the 7.62mm machine gun M60 is classified as small arms ammunition and is issued in the form of a complete round (cartridge). A complete round consists of all the components necessary to fire the weapon once, that is, projectile (bullet), cartridge case, propellant powder, and primer.

Based upon type of projectile, ammunition authorized for use in this gun is classified as outlined below.

a. Armor-piercing-incendiary cartridge, for use against light armoured or other bullet resisting targets where armour-piercing and incendiary effects are desired.
b. Armour-piercing cartridge, for use against light armoured or other bullet resisting targets where armour-piercing effects are desired.
c. Ball cartridge, for use against light material targets and personnel.
d. Dummy cartridge is completely inert, but simulates service ammunition for practice in loading the weapon.
e. Tracer cartridge, for observation of fire, incendiary effect, and for signaling.

General Identification. The type, calibre, model, and ammunition lot number, including the symbol of the manufacturer, are necessary for complete identification of small-arms ammunition. Ammunition for the 7.62mm weapon is completely identified by its appearance, the painting of the bullet tip, and the markings on the packing containers.



7.62mm Cartridge (Photo courtesy of Woodin Laboratories).

Chapter 26

20mm M621 AUTOMATIC CANNON

AME-FRANCE

20mm M621 Automatic Cannon

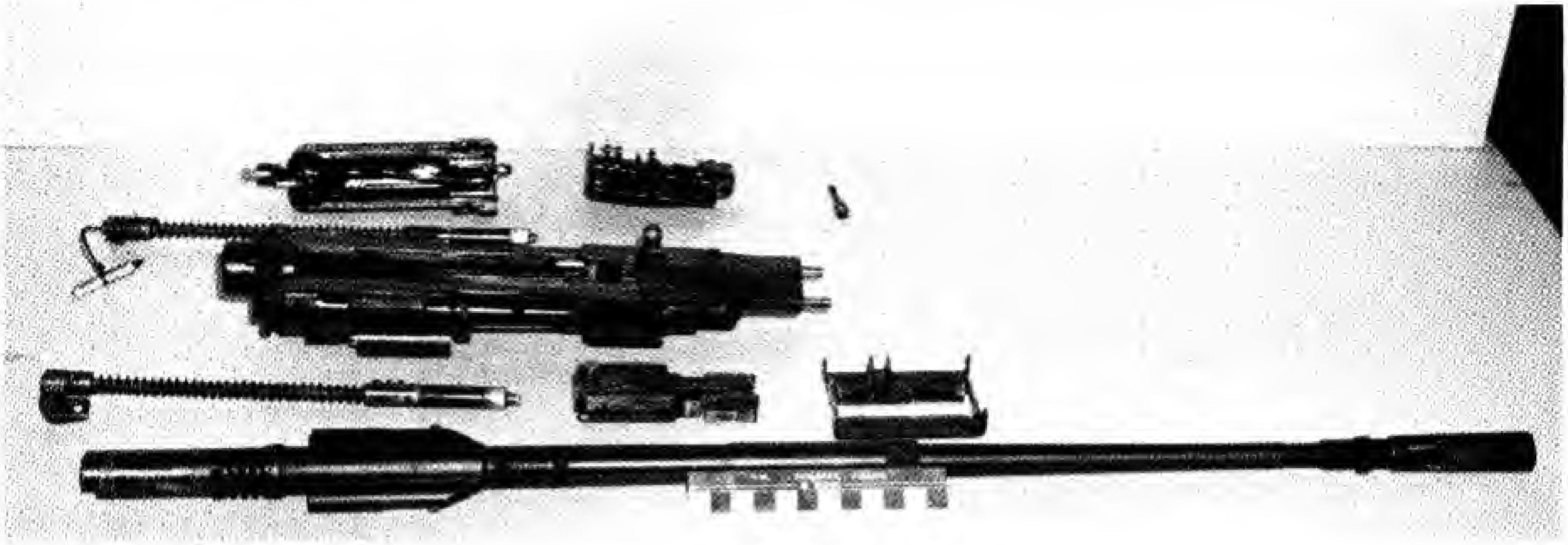
History

Recognizing the shortcomings of the Mk 16 20mm Hispano-Suiza gun, the Naval Ordnance Systems Command initiated, in 1962, a program to select from currently available, modern weapons, an improved 20mm surface applications gun. The weapon, in the final version, would be suitable for firing from a pintle mount, would operate on the open bolt principle to preclude cook-off, could be loaded and fired by one man, and would be quickly and easily field stripped without the use of tools. It should have a quick change barrel, at least two rates of fire with a 600 rpm maximum, and be chambered for 20mm M50 series ammunition, both electric and percussion primed.

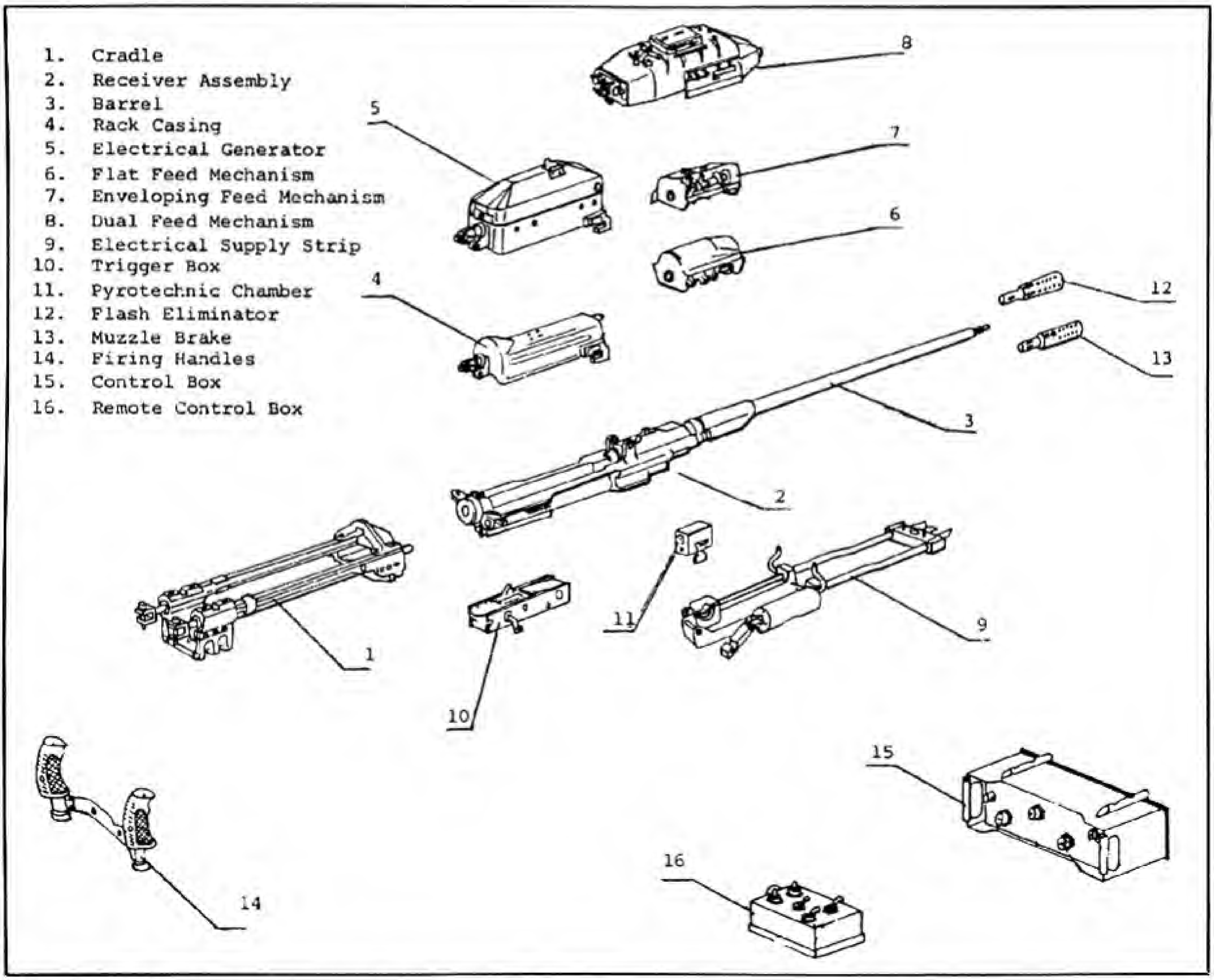
The first evaluations of improved 20mm surface guns began at Naval Weapons Laboratory Dahlgren in April 1969 with two candidate weapons in competition; the General Electric 120B and the Mk 22, developed by the Naval Ordnance Station, Louisville. During the summer of 1969, a total of 18,000 rounds was fired from the GE120B and 2000 rounds from the Mk 22. Although both weapons showed promise, neither was judged sufficiently refined at that stage to pass service acceptance tests. It was decided to conduct another comparative evaluation at a later date to permit faults in these two guns to be rectified and to allow other vendors to submit additional weapons for consideration.

The second evaluation began at NWL/D in February 1971 with four candidate weapons: improved versions of the GE120B and the Mk 22, the German Mauser-Bauer Model B and the French AME 621 manufactured by Material Defense Associates. In order to qualify for candidacy in this evaluation, it was stipulated that each weapon system be a completed item, capable of fulfilling all requirements of the tests without further design modification or development.

The AME 621 weapon had overall low system reliability primarily because system components did not function as intended and stoppages were frequent. The rate of fire capabilities of this weapon were not compatible with the intended environment. However, this weapon had some highly desirable design features which were unique among the weapons tested. It was the lightest and most compact of the weapons; and easiest to field strip and assemble. These features were realized primarily by increased complexity of the gun system which, in turn, tended



AME 621 20mm Machine Gun


1. Cradle
2. Receiver Assembly
3. Barrel
4. Rack Casing
5. Electrical Generator
6. Flat Feed Mechanism
7. Enveloping Feed Mechanism
8. Dual Feed Mechanism
9. Electrical Supply Strip
10. Trigger Box
11. Pyrotechnic Chamber
12. Flash Eliminator
13. Muzzle Brake
14. Firing Handles
15. Control Box
16. Remote Control Box
8
5
7
6
4
12
13
3
2
11
9
1
10
15
16
14

AME 621 Exploded View of Principal Sub-Assemblies to lower reliability over that of the less complex designs.

General Description

The AME 621 20mm machine gun's name was derived from the letter A, which stands for Atelier, meaning shop or factory. The letters M and E are the first and last letters in the name Mulhouse, which is the town where the gun was made. The numbers 62 stand for the year the gun was invented, 1962, and 1 means it was the first gun made.

The AME 621 20mm machine gun is an air cooled, self-powered, open-bolt, gas-operated, belt-fed, weapon having a rate of fire of 750 rounds per minute (rpm). It is chambered for M50 series ammunition, accepts steel or brass cases interchangeably, and can be easily configured to fire either electrical or percussion primed ammunition.

The basic weapon is designed to feed from the right side using a cam-driven flat feeder indexing on rearward travel of the bolt. The weapon can be quickly converted to left hand feed, using an enveloping feeder, and it can also be configured with a dual feed mechanism which permits selective feeding from either side. The end-stripping M12 link is used in the system. Ammunition is not lubricated prior to firing and headspace is fixed on the weapon.

The gun can be fired either electrically or mechanically. When firing electrically a low rate of fire of 300 rpm can be selected as well as the gun's natural rate of fire. The weapon can be recharged automatically during firing (in case of a dud round) by installing a pyrotechnic cartridge in a special re-arming mechanism. A fresh cartridge must be inserted after each automatic charging. Also, when firing electrically, the gun can be fired single shot (actually semi-automatic). In this mode the bolt chambers a round and remains in the forward (battery) position until the gun fires. The bolt then chambers another round and remains in the forward position. When firing automatically the bolt remains to the rear after firing, i.e. open bolt operation.

The weapon is mounted in a recoil absorbing cradle. It has a quick change barrel, muzzle brake, and flash hider. It can be easily and quickly field stripped without the use of tools and the component parts of the weapon are so designed that improper reassembly is difficult if not impossible.

The basic weapon weighs 100 pounds, with barrel and flat feeder, and the cradle weighs 27 pounds. The length of the complete gun with flash hider is 87¼ inches. Width and height depend on feed configuration.

Characteristics

Calibre	20mm
Weight of Complete Gun	100.3 lbs.
Weight of Cradle	27.6 lbs.
Length of Complete Gun	87 inches
Length of Barrel	59 inches
Width when in Cradle	8 inches
Height when in Cradle	9.8 inches
Height when in Cradle with Selective Feed Mechanism	12 inches
Length of Rear Feed Mechanism	16.9 inches
Rate of Fire	740 & 300 rpm
Recoil Stroke (elevation 0°)	2 inches reverse and 0.68 inch forward
Trigger	Single Round or Burst
Capping Voltage:	
Combat Cartridge	250 volts D.C.
Recocking Cartridge	24 volts D.C.
Feed Voltage	24 volts D.C.

The M621 was designed to replace the calibre .50 machine gun. The manufacturer states that low recoil levels combined with a recoil shock limiter simplifies compact mounting arrangements for light aircraft, especially helicopters, assault or patrol boats and light or heavy armored vehicles.

It utilizes the energy of expanding gases for the mechanical cycling of the gun mechanism and features a sliding breech block to accomplish functions of feed, chambering, ejection and rearming.

The basic gun permits selection of burst or single round firing and when controlled electrically (24 vdc). Automatic burst limitation and 300 or 720 rounds per minute firing rate may be selected. Other features provide for automatic recharging single or dual ammunition feed configurations and a self contained generator for firing electrically primed cartridges.

Cycle of Operation

The functional sequence of the gun cycle of operation will be discussed in stages beginning with the detonation of a round. The cycle of operation is taken from an operating manual on the weapon.

Ignition and Gas Operation Phase. Upon ignition the pressure build-up expands the shell case and forces the projectile into the rifling grooves. As the round passes gas ports on each side of the barrel, the gas pressure forces the barrel thrust pistons back against the gas piston assemblies in the receiver. This thrust is transmitted to the actuating piston in the breech block drawing the slide backward to unlock the two crutches in the bolt. At the same time, unlocking plungers are forced against the crutches to aid their release.

Unlocking and Recoil Phase. As the slide continues rearward the crutches fold against the bolt, the breech block begins to move rearward under continued thrust from the gas pistons and residual gas pressure of the cartridge case (about 1,160 psi). During this rearward travel to the buffer, the following occurs:

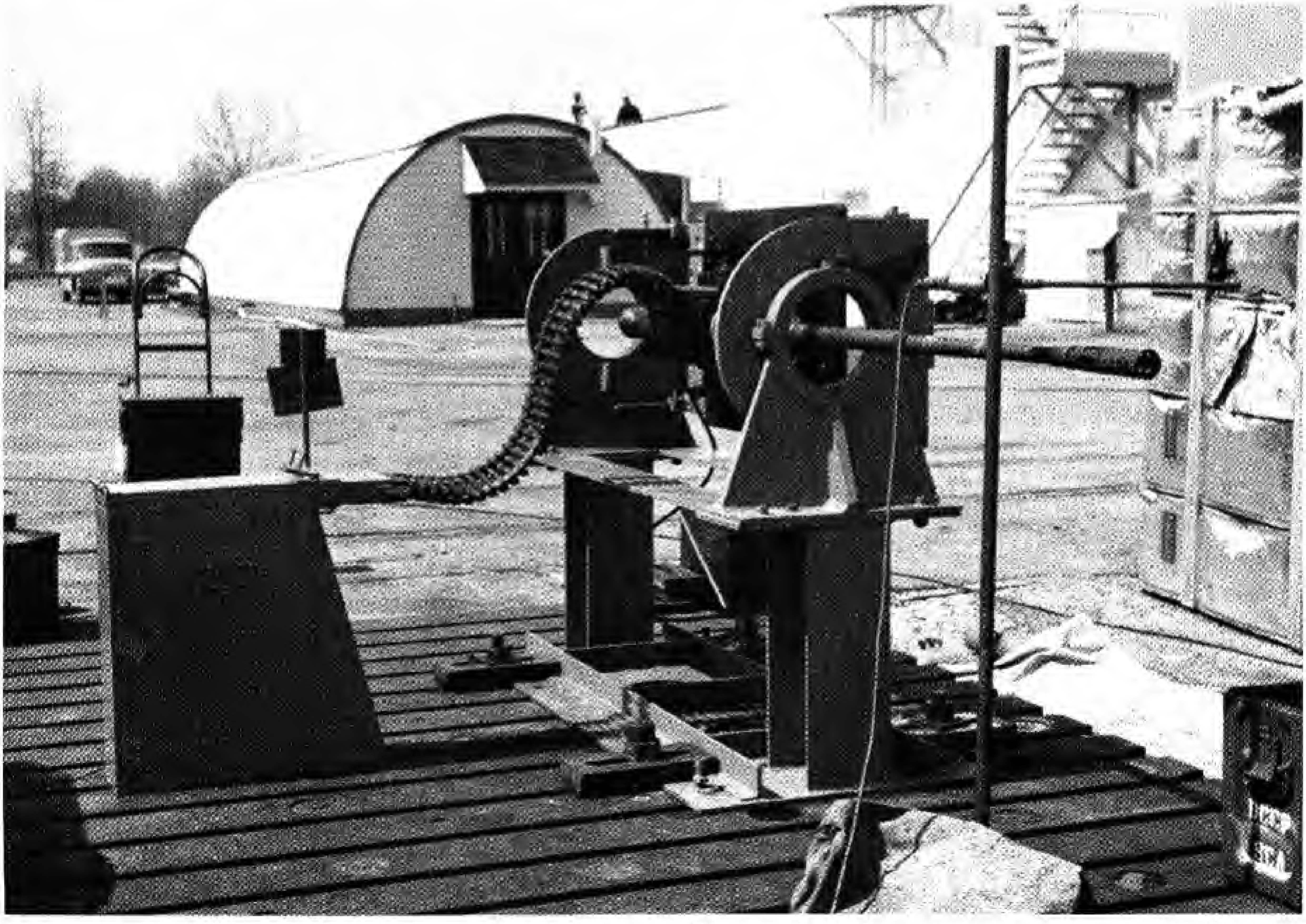
- extraction and ejection of the empty case
- drive of the feed mechanism
- compression of the recoil springs
- ejection of the link
- control latch operates to raise the sear

At the end of the rearward travel the buffer stops the breech block and starts it forward with the aid of the decompressing recoil springs. The breech block is prevented from moving forward by the sear in the trigger box. During burst or precision single round fire the sear is depressed allowing the breech block to continue its travel forward.

Counterrecoil and Locking Phase. When the sear is depressed, the breech block is driven forward by the force of the recoil springs. A linked cartridge, positioned on the feeder base plate during the recoil phase is extracted from its link by the front face of the bolt, and is guided down and forward into the firing chamber.

When the breech block reaches its forward position, the two locking blocks move outward into their housing in the receiver. As they move apart, the slide moves forward locking the breech block assembly.

When firing electrically primed rounds, the actuating pistons in the slide trip the plunger in the firing pin assembly releasing the firing pin which is



AME 621 20mm Machine Gun at Naval Weapons Laboratory, Dahlgren, Virginia.

driven by spring pressure into the ignition cap of the chambered round. The cartridge contact sensor circuit is closed by the presence of a chambered round, and electrical ignition of the primer occurs.

When firing with the percussion bolt, the firing pin is driven forward by action of the slide, thus striking the percussion primer.

Feed Mechanism Function—Flat or Enveloping Feed. The mobile rack follower on the bolt rides in the rack casing assembly. The rack is helical with a 72° twist over its length. Consequently, during recoil the rearward movement of the bolt causes the rack to rotate 72° and moves the connecting lug on the ratchet and pawl assembly in a 72° arc. This movement is transmitted to the drive spindle which also rotates 72° or 1/5th of a turn during recoil.

The drive spindle splines engage the feed sprocket which feeds one round into position on the feed base plate. At the same time the empty link from the previous round is ejected from the feed housing.

Trigger Function. The trigger controls the release of the breech block during its forward movement. The functions of components differ depending upon the setting of a firing selector switch: safety, burst, single round. In all cases during recoil, the breech block causes the counter latch to rotate and to transmit by its spring a rotational force to the control latch.

During burst firing the control latch cannot rotate being stopped by the pawl. When the trigger control rod is released the pawl is withdrawn and the trigger control latch rotates to operate the sliding arm which raises the sear. The sear engages the bottom of the breech block preventing its forward or counterrecoil movement.

During single round fire, the pawl releases the control latch. As the breech block moves forward, the counter latch rotates and the control latch rotates to operate the sliding cam. At the same moment, the catch cam rides up on the tripper preventing the lock from releasing the sliding cam. The sear is held up engaging the breech block. To fire a second shot the trigger must be released causing the catch assembly cam to ride down the tripper. Then, the trigger is depressed causing the catch cam to rise up under the tripper which releases the lock and the sliding cam moves back lowering the sear.

In the safety position the tab on the firing selector shaft locks the catch assembly preventing movement of the trigger. When the breech block is forward, the catch assembly cannot rotate and, therefore, the catch cam will not move to lock the sear in a raised position. Consequently, the gun cannot be re-armed when set on safety.

Electric Firing Cycle. The mechanical functions occuring during percussion or electric firing are essentially the same except that detonation of the electrically primed cartridge does not occur until the cartridge sensor circuit is closed and the priming voltage (250 VDC) is transmitted to the firing pin. In addition, electric firing permits the use of pyrotechnic rearming in case the cartridge fails to detonate.

Electrical Functions. The electrical circuits of the gun provide control and safety functions necessary for electrical firing and include:

- the priming circuit for combat cartridges (250 VDC)
- the control and priming circuit for the pyrotechnic cartridge (24 VDC)
- the cartridge sensor circuit
- the firing solenoid circuit (24 VDC)

Electrical Firing. When the breech block is locked in its forward position, the priming circuits for firing the ammunition and the pyrotechnic cartridge are closed. The priming voltage is applied when the cartridge sensor circuit is closed by the presence of a cartridge in the chamber. If the pyrotechnic control circuit remains closed longer than .33 of a second after the 250 volt priming, voltage is applied, the 24 volt pyrotechnic priming circuit is automatically supplied by the control box.

Test Results

Overall reliability exhibited by the AME 621 during this evaluation was generally low as judged by the Mean Rounds Between Stoppages (MRBS) values. Two hundred seventy-one rounds per stoppage average and ranging from 142 to 375 rounds per stoppage depending on combination of ammunition type, and feeder mode used. Largely, this poor reliability was influenced by two features: the dual feed mechanism, and the electric generator.

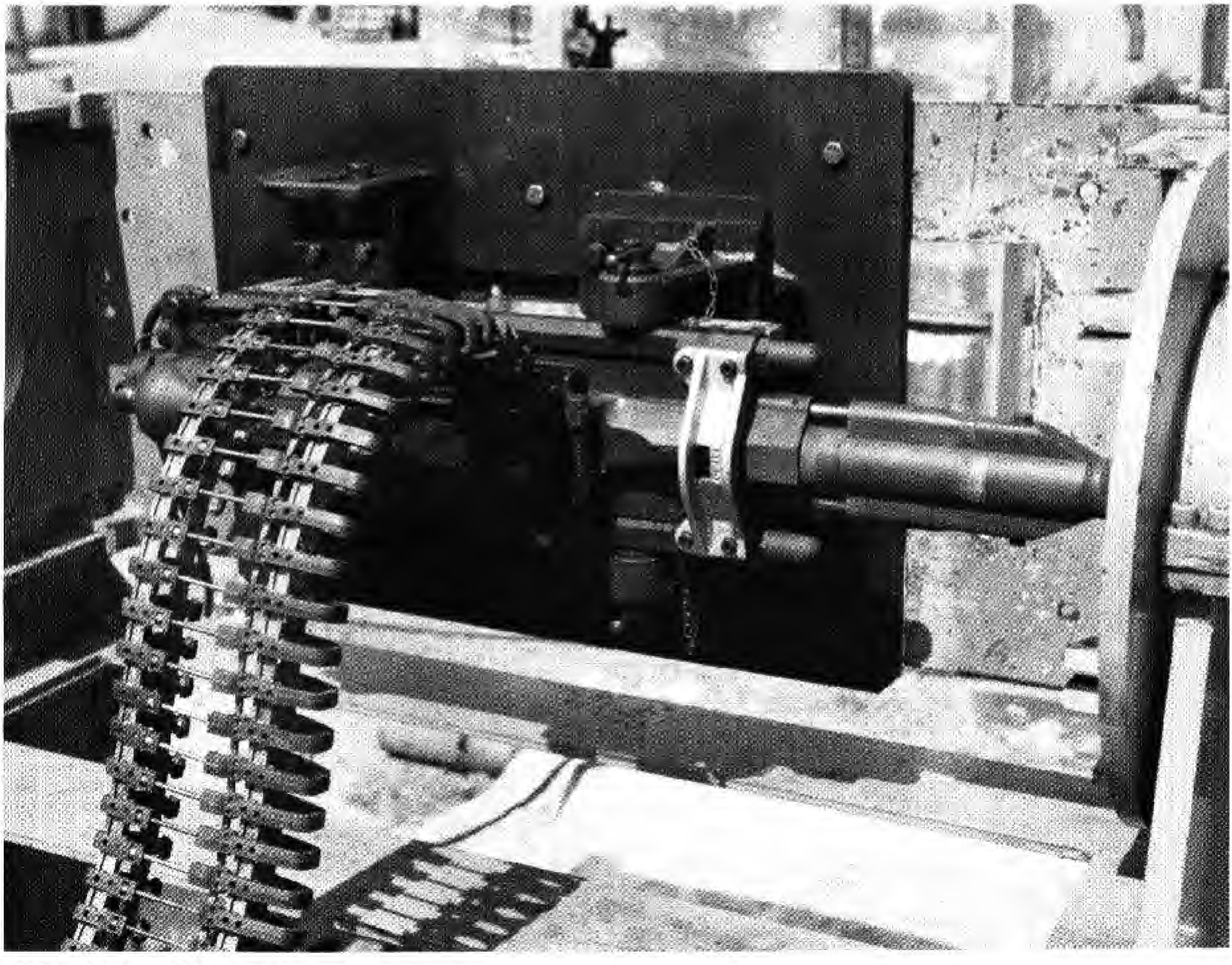
The dual feed mechanism of the AME 621 is a desirable weapon characteristic. However, the prototype unit used in the evaluation was difficult to load properly, and was susceptible to frequent jamming and misfeeding during firing, especially during the passing of the trailing end of the belt through the feeder. At one point in the tests, two dummy rounds were attached to the end of each belt in an effort to stop the frequent jams but this proved unsuccessful. The most frequent cause of trouble was failure of the feeder to maintain positive control over the rounds and links during operation.

The electric generator is also a desirable weapon feature because it enables the weapon to fire electric primed ammunition with no external power source. However, performance reliability of the prototype unit used in the evaluation was low, producing frequent failures to fire which were largely unexplainable. A total of 970 rounds was fired using the generator; MRBS was 167 rounds. MRBS for electric primed ammunition fired using an external power source was 375 rounds.

Performance of the enveloping feeder is critically influenced by the ammunition supply outlet location; it must be as nearly horizontal with the enveloping feeder entrance as possible because placing the ammunition box too low causes excessive torque on the feeder during firing and can result in a jam. As a result of such a jam there is upward pressure on the feeder and, to clear the weapon, the rack casing shaft has to be driven out of the feeder. That occurred twice during this evaluation, producing two jams classed as major stoppages because of the time and effort required in each case to clear the weapon.

The manner in which the ammunition chuting (gun end) is attached to the feeder baseplate was inadequate. Two stoppages occurred during the evaluation when the ammunition chuting pulled loose from the feeder base plate attachment. This feature is definitely not suitable for service use.

Cleaning of the gas port plugs every 1,000 rounds was necessary to assure proper operation of the weapon. Gas port plug threads are susceptible to damage while attempting to clean the gas ports. The wiring harness and receiver contacts used when the weapon is configured to fire electric primed ammunition were fragile and susceptible to bending and breaking.



AME 621 20mm Machine Gun

This was a frequent cause of erratic firing and stoppages during the evaluation.

The M12 link used in the AME 621 gun, an end-stripping link of the disintegrating type, apparently has a high, as well as variable, stripping force; during evaluation stoppages occurred in which the bolt only partially stripped the round from the link. Because the link is of the end-stripping type, it has no positioning detents and proper belt calibration, therefore depends strictly on proper adjustment of the belting machine. Rounds are also more susceptible to being knocked out of position during handling when belted in links with no positioning detents.

All of the feed mechanisms used with the AME 621 are indexed by a spiral cam actuated by a lug on the bolt. The mechanical advantage of the cam arrangement used is fairly low as evidenced by the belt pull figures obtained during the evaluation. In certain areas of the weapon, clearances are minimal, especially between the bolt and bolt track. This probably explains the weapon's performance during the rain test.

A serious weakness of the AME 621 weapons used in the evaluation is their inability to fire at reduced rates using percussion ammunition. A weapon intended for surface use against surface targets should be capable of rates of fire much lower than 750 rpm, which is the only rate at which the AME 621 will fire percussion ammunition.

The AME 621 is the lightest and most compact of the four weapons tested. When firing electric primed ammunition using an external power source (not using the generator) and the control box unit, the weapon can be fired in the single round precision mode, and at a rate of 300 rpm as well as the natural rate. A burst limiter is also available with the control box unit, allowing selection of three, five, eight, or fifteen round bursts as well as an unlimited burst length.

The weapon is very accurate, especially when firing in the precision single round mode. Barrel life of the weapon is outstanding; after 8,000 rounds on a particular barrel, velocities were close to 3,200 fps, as compared to a new barrel with a velocity of 3,400 fps, and patterns were still good.

The pyrotechnic re-arming device used to automatically charge the weapon performed satisfactorily during the evaluation.

In all but two specific cases, jams and stoppages encountered were quickly and easily cleared. Stoppages could be cleared safely in all cases. No safety deficiencies were observed at any time during the evaluation which could be attributed to the design or nature of operation of the AME 621 system.

Ammunition

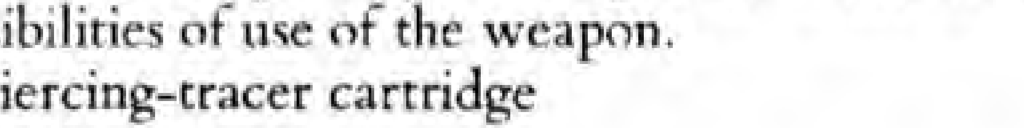
The M621 fires all types of U.S. 20mm type M56 ammunition with M12 belt link and is compatible with existing U.S. 20mm ammunition feed and handling systems typically used with the M39 and Vulcan guns installations. This ammunition, widely used throughout the world, assures adequate logistic support from existing inventories. Modular construction fosters quick disassembly and interchangeability of main components or parts.

This ammunition is very suitable thanks to the following characteristics:

- electric ignition which grants a large flexibility of use and permits firing when the breech is in open or closed position, with the possibility to fire with varying rates of fire, with limited bursts and numbering of the rounds.
- high muzzle velocity entailing a fair firing potential especially for the armour-piercing shells.
- small (less than 168mm length and 30mm diameter).
- lightweight (260g).

The range of ammunition has been completed by other shells especially developed to meet all the possibilities of use of the weapon.

Piercing-tracer cartridge
Explosive tracer
HE cartridge
Incendiary cartridge
Drill-tracer cartridge



M50 Series, Electric-Primed Ammunition. (Photo courtesy of Woodin Laboratories.)

Chapter 27

35mm ANTI-AIRCRAFT GUN

OERLIKON, KD SERIES (KDA and KDC)

35mm Oerlikon Anti-Aircraft Gun

History

The KD series are essentially scaled up from the 20mm Oerlikon 204Gk (now known as the KAA). Work on the 35mm guns began about thirty-five years ago when Oerlikon calculated that 35mm was the optimum calibre for anti-aircraft guns. Based on that determination the various KD series guns have been developed. Several guns, including the water cooled Mk 352, preceeded the current air cooled Mk 353. These guns then became the KD series when Oerlikon changed their system of model numbers. K stands for Kannon, D indicates 35 millimeter, and the third letter (A or C in this case) indicates the version.

A variety of mounts are available for this weapon depending upon the needs of the user.

The Super-Fledermaus towed twin 35mm anti-aircraft unit is used in many countries but is rapidly becoming obsolete in NATO countries with the advent of the tank chassis mounted versions. For example, Austria has begun replacing the "Fledermaus" with Flak-Panzers. As recently as 1967, however, the "Fledermaus" was extensively tested by the Japanese and found to be "an AA gun of very high efficiency, especially toward low altitude targets."

The 35mm Oerlikon-Contraves Flak-Panzer was developed to the point of production and several countries purchased them in quantity. Among others, Austria bought the system and the Netherlands ordered 35 Flak-Panzers. These AA tanks have been under development since 1963 and the first prototype was delivered to West Germany in 1968.

An early version of this weapon, the Mk 352 was tested by the U.S. Navy in a twin naval turret mount with the guns being water-cooled.

Description

The Oerlikon 35mm automatic gun is a gas-operated gun with a positively locked supporting snaplock.

The receiver and barrel slide on the cradle-bearing during recoil. The gun cover, containing the feed mechanism, does not recoil. The manual cocking device is mounted on the gun cover and does not move relative to the cradle. To reduce the recoil forces, the barrels are fitted with muzzle brakes. On raising the gun cover, all main working parts of the gun are easily accessible.

The guns are completely interchangeable and can be assembled for left or right hand feed without the use of additional parts.

Purpose and Description

The KD series of Oerlikon 35mm anti-aircraft guns were widely applied in various mounts for anti-aircraft use. All known mounts are twin and include naval, tank, and towed types. This gun was designed to provide air defense capability against low to medium altitude enemy aircraft. The weapon was originally applied to naval mounts but more recently a wider variety of applications have been made. Various versions are in use by a dozen countries.

The current versions of the KD series guns are air cooled, gas operated, and swinging flap locked, earlier versions were water cooled. These guns fire a rather large projectile (more than 1.2 pounds) at a muzzle velocity of 3800 feet per second. The rate of fire is 550 rpm for a single gun.

Two versions are available, the KDA, which is belt fed and the KDC, which is a "linkless" feed replenished with five round clips. The latter uses a conveyor system to strip the cartridges and move them to the gun. The systems vary depending upon the mount.

Cycle of Operation

Breech Action. The weapon is loaded (the ammunition has been fed sufficiently for the first cartridge to lie deflected in front of the breech, while a top guide prevents any deflection upwards). The breech is held in the open position by the sear against the force of the tightened return springs.

On lifting the trigger lever, the sear link is disengaged from the breech. The breech, now freed, is thrust forward by the return springs, and rams the first cartridge into the chamber.

The cartridge is pushed into the chamber as the return springs push the rear of the breech forward. The slide, connected to the breech, presses the locking catches outwards and into the supporting bolts. In the last part of the forward movement, the base of the cartridge case is pressed into the extractor claws.

As soon as the locking catches have fully swung out, the rear part of the breech and slide move fully forward. The striker pin secured to the slide fires the cartridge. The rebound cushion absorbs the rebound of the breech.

When the projectile passes the gas vents in the rear portion of the barrel, a portion of the gases escape through the vents into the gas cylinder. The gas pistons are driven back and transmit their motion through the return springs and the rear of the breech to the slide, which in turn draws back the striker. The slide, travelling rearward, frees the locking catches.

Characteristics

Bore Size	35mm
Muzzle Velocity	3840 fps
Rate of Fire	550 rpm
Basic System of Operation	Gas
Locking System	Propped Lock
Feed System	Sprocket Type
Type of Feed (Location)	Magazine
Method of Chambering	Ram
Initial Extraction	Oiled Cases
Type of Receiver	Machined
Weapon by Source	Foreign
Ammunition Type	Oerlikon 35
Gun Weight	815 lbs.
Barrel Length	124 in.
Barrel Weight	310 lbs.

The residual pressure of the propellant gases and the already recoiling rear portion of the breech exert a force acting rearward on the breech head. The locking catches thus slide over the bevelled surfaces of the supporting bolts into the breech head and the breech is unlocked. The cartridge case is held by the extractor claws on the breech head.

The breech return springs are compressed by the recoil of the breech, while the gas pistons move forward again under the pressure of their springs. At the same time, the feed pawl release shaft, controlled by the breech, feeds the next cartridge (pushed into the weapon by the ammunition feed) over the breech run.

The cartridge case, drawn back with the breech recoil, strikes the nose of the flexible ejector with the upper edge of the cartridge base so that the case is tipped over the claw of the extractor and thrown out downwards.

The breech recoil controls the feed into the weapon cover in such a way that the next cartridge is ready to be fed forward by the breech head at the end of the interval between rounds.

At the end of its recoil, the breech is caught by the hydraulic breech buffer. The breech return springs are now again compressed, and the gas pistons are in the forward position.

Trigger Action. The breech is in the rear position (the sear holds the breech in the cocked position). The sear carrier lock prevents any downward movement of the sear carrier.

By lifting the trigger catch, the trigger slide, and with it the sear carrier lock, is slid forward, so that the sear carrier with the sear is pressed downwards by the breech, which is under the pressure of the compressed breech return springs. The sear slide is pushed forward by the springs and thereby holds the sear carrier in its lower position.

If the trigger is released while the breech is recoiling and is over the locking pawl, then the latter cannot move upwards. Because the trigger slide is thereby held fast in its forward position, the sear carrier with the sear cannot swing out into the rear caught-back position. The trigger thus remains drawn.

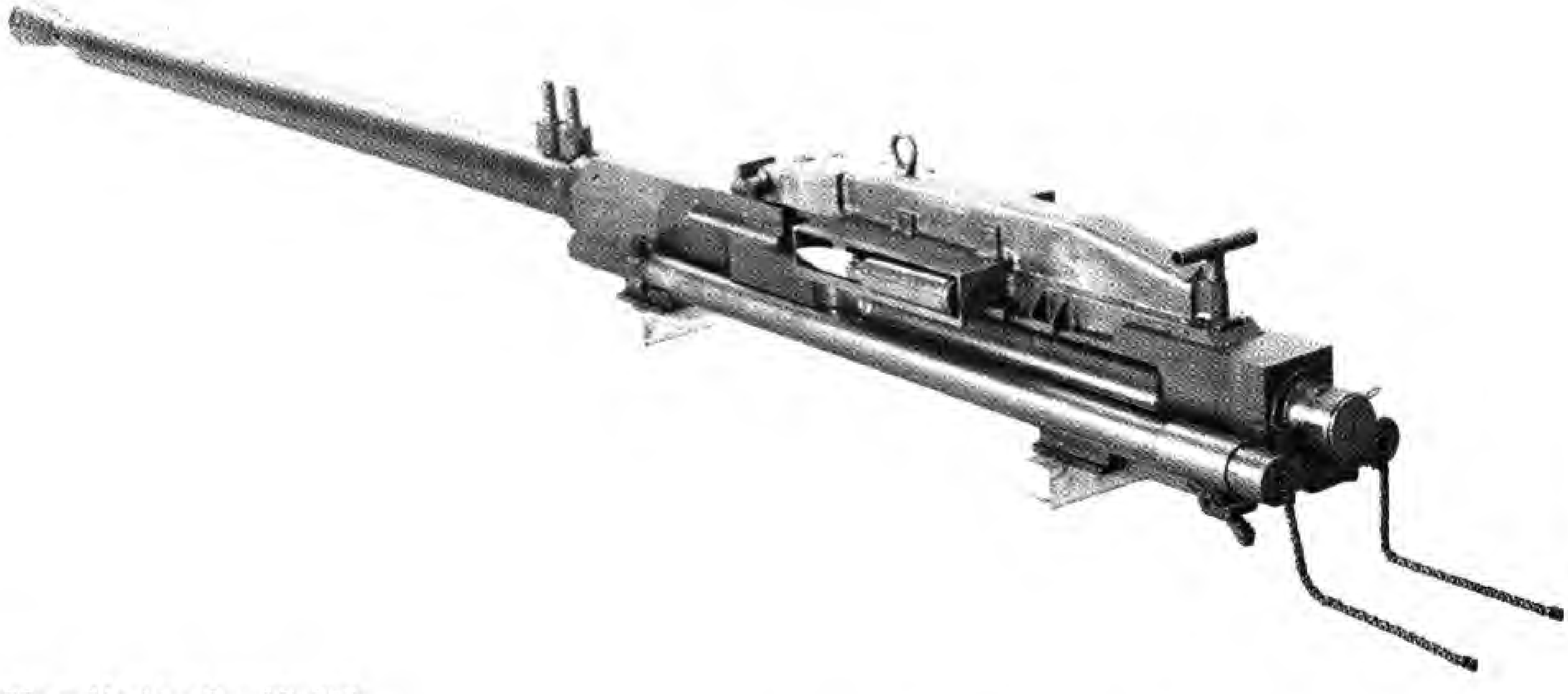
As soon as the breech in its renewed run forward has freed the locking lever, then the latter can swing out and upwards. The retaining lever, swinging up with the locking lever, frees the trigger slide. The latter draws sear carrier lock and sear slide to the rear, so that the sear carrier is returned by the spring to the rear caught-back position together with the sear.

35mm Oerlikon Ammunition (Photo courtesy of Woodin Laboratories.)

SECTION I.

35mm Mk 352 MACHINE GUN

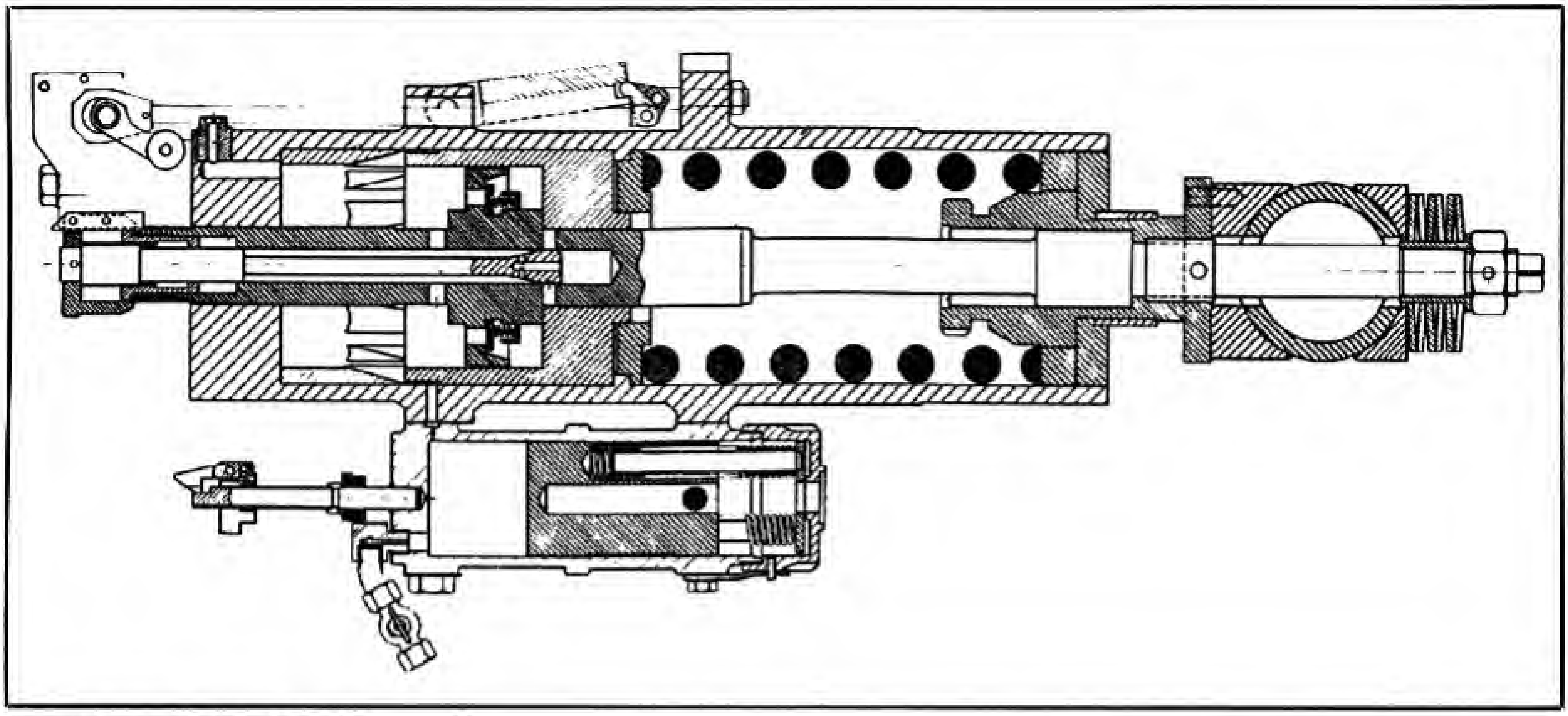
OERLIKON



35mm Machine Gun Mk 352

Introduction

The 35mm Mk 352 Machine Gun is gas operated and uses a percussion firing system. The water cooled barrel is attached to the gun by a quick change lock. Recoil is controlled by a spring-hydraulic recuperator. The breech block is driven by two sets of springs



Recoil System of the Mk 352

and locked before firing. The complete feed system is attached to the cradle and does not take part in the recoil.

Recoil System

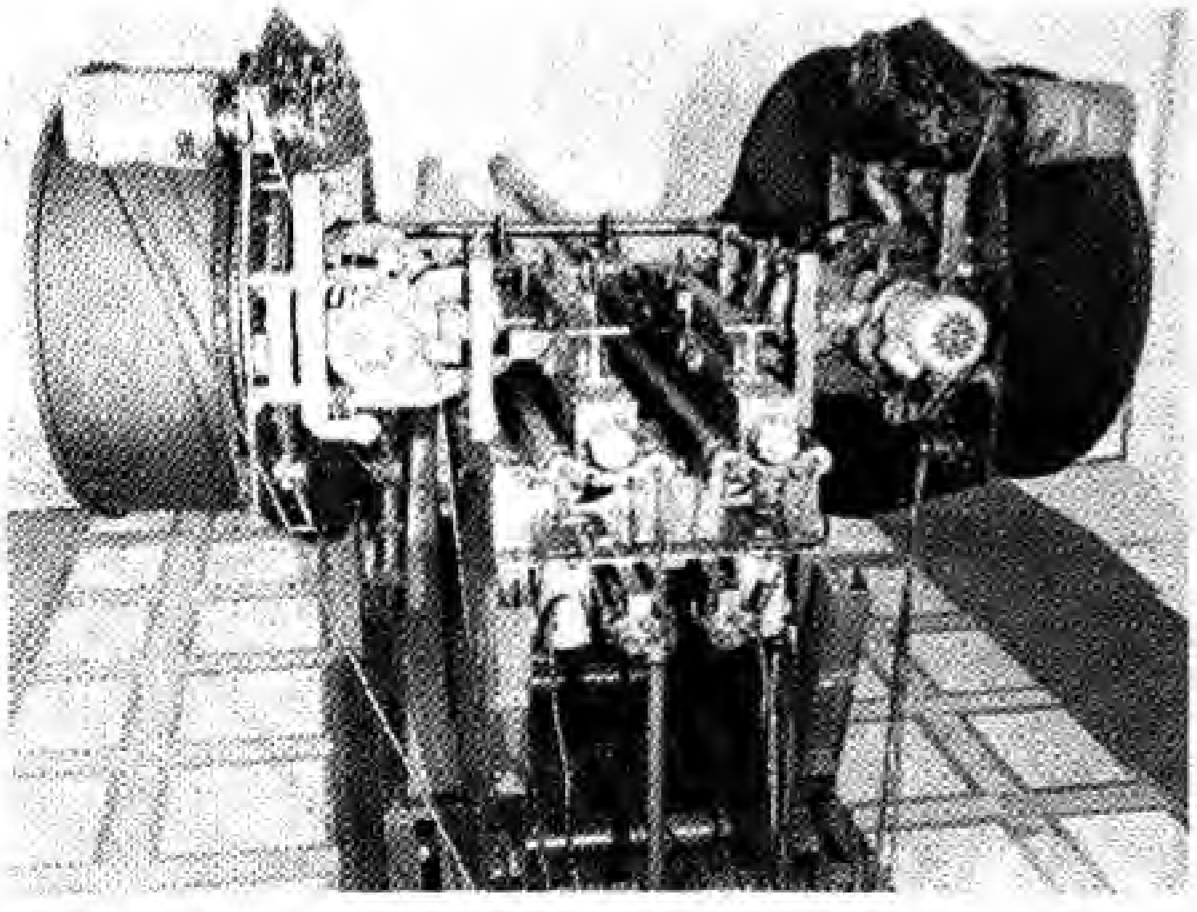
The recoil system on the Mk 352 consists of a main cylinder containing a recoil spring and a hydraulic run-out control. A hydraulic reservoir is mounted underneath.

The gun is locked to the main cylinder, and the piston rod is attached to a cross member of the cradle.

On recoil the cylinder slides rearwards against the recoil spring. The hydraulic fluid flows freely through the check valves in the piston. On run-out the recoil spring drives the cylinder with gun forward. The speed of forward movement is controlled by the hydraulic flow through an adjustable valve in the piston rod. A spring back between the end of the piston rod and the cradle cross member absorbs the shock on complete run-out. The pressure is maintained in the hydraulic system by a spring loaded piston in the reservoir.

Complete Feed System

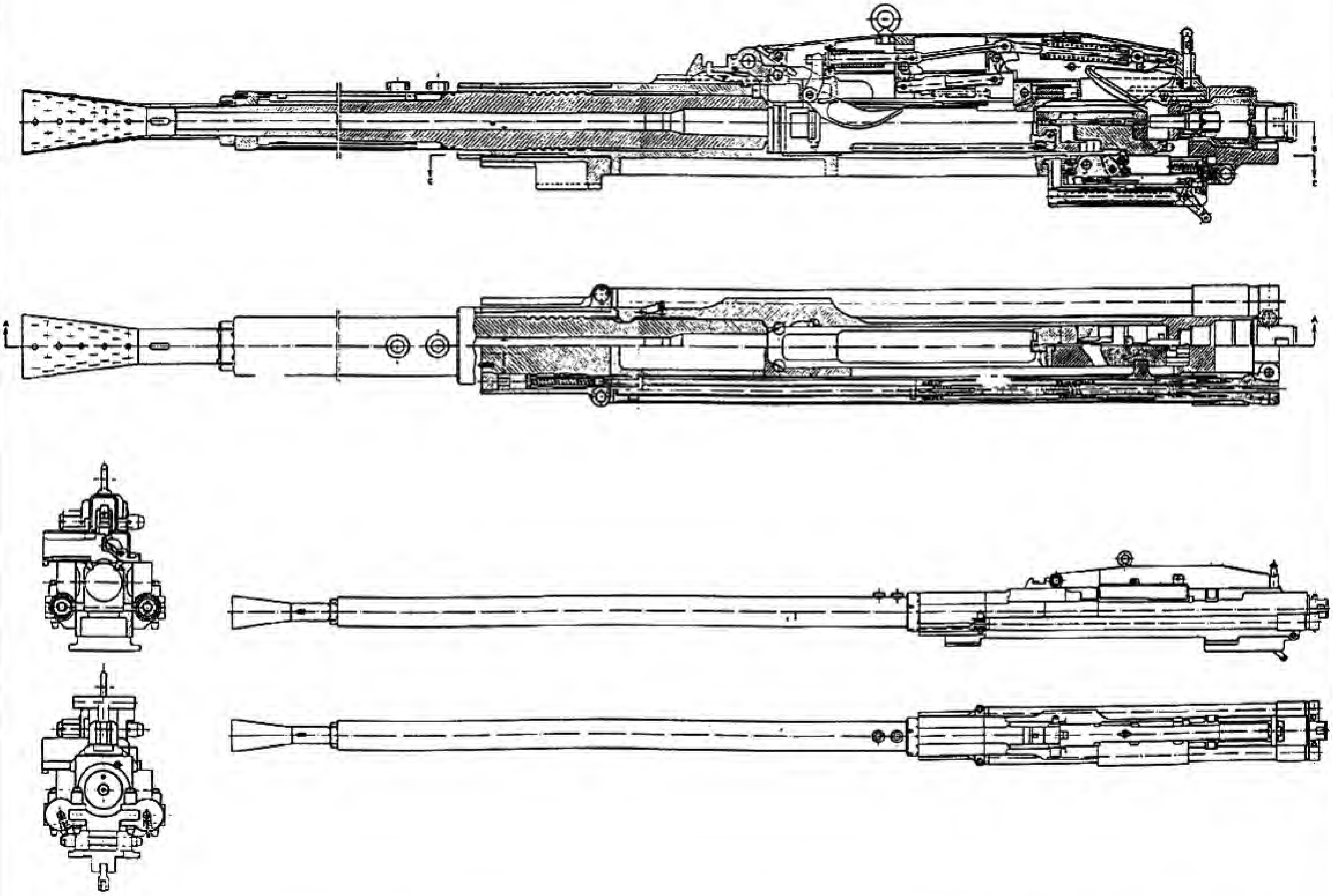
The Mk 352 has its own ammunition supply system, consisting of a storage drum and feeding mechanism. The system is attached to the trunnion with



Mk 352 Complete Feed System

Characteristics

Calibre	35mm
Muzzle Velocity	3840 fps
Rate of Fire	550 rpm
Barrel Length, 90 cal.	12.4 in.
Number of Grooves	20
Progressive Twist	0 to 6°30′
Overall Length of Gun	18.5 in.
Weight:	
Gun	815 lbs.
Barrel Group	310 lbs.
Breech Housing Assembly	505 lbs.
Cover (Non Recoiling)	87 lbs.



Mk 352 Oerlikon

the drum inclined at 11°20′ to the bore line, and elevates with the cradle. Each system holds up to 231 rounds. In normal operation, firing stops automatically when the storage drum is empty and 15 to 16 rounds are left in the feeder. Firing can be resumed as soon as more ammunition is loaded into the drum. Provision is also made for firing until the feeder is empty (four rounds unused in feed tray) but from this position the gun must be cleared before reloading.

The rounds follow on a S-shaped path through the feeder over two sprockets, one of which is able to swing, varying the length of the path by five to six rounds. The drum and conveyor, which can supply rounds to the feeder faster than the gun can fire, are driven through a clutch controlled by the feeder.

The rounds are combed from the drum by the conveyor into the feed supply wheel, which pushes them into the feeder. When the feeder is filled to maximum capacity, it disengages the clutch, stopping drum, conveyor and feed supply wheel.

During firing, the feeder, which is driven through a friction clutch, maintains a constant pressure on rounds towards the gun. As the swinging sprocket falls from the maximum capacity position, the clutch to the drum is re-engaged.

Main Components

Barrel Group. Gun Barrel with water jacket, Flash Eliminator and two Gas Ports. Attached to the Breech Casing by Bayonet Lugs, permitting rapid change.

Breech Casing Assembly. Breech Casing with Breech Buffer, Return Springs and Front Bracket. Slides on Cradle against the Recoil System.

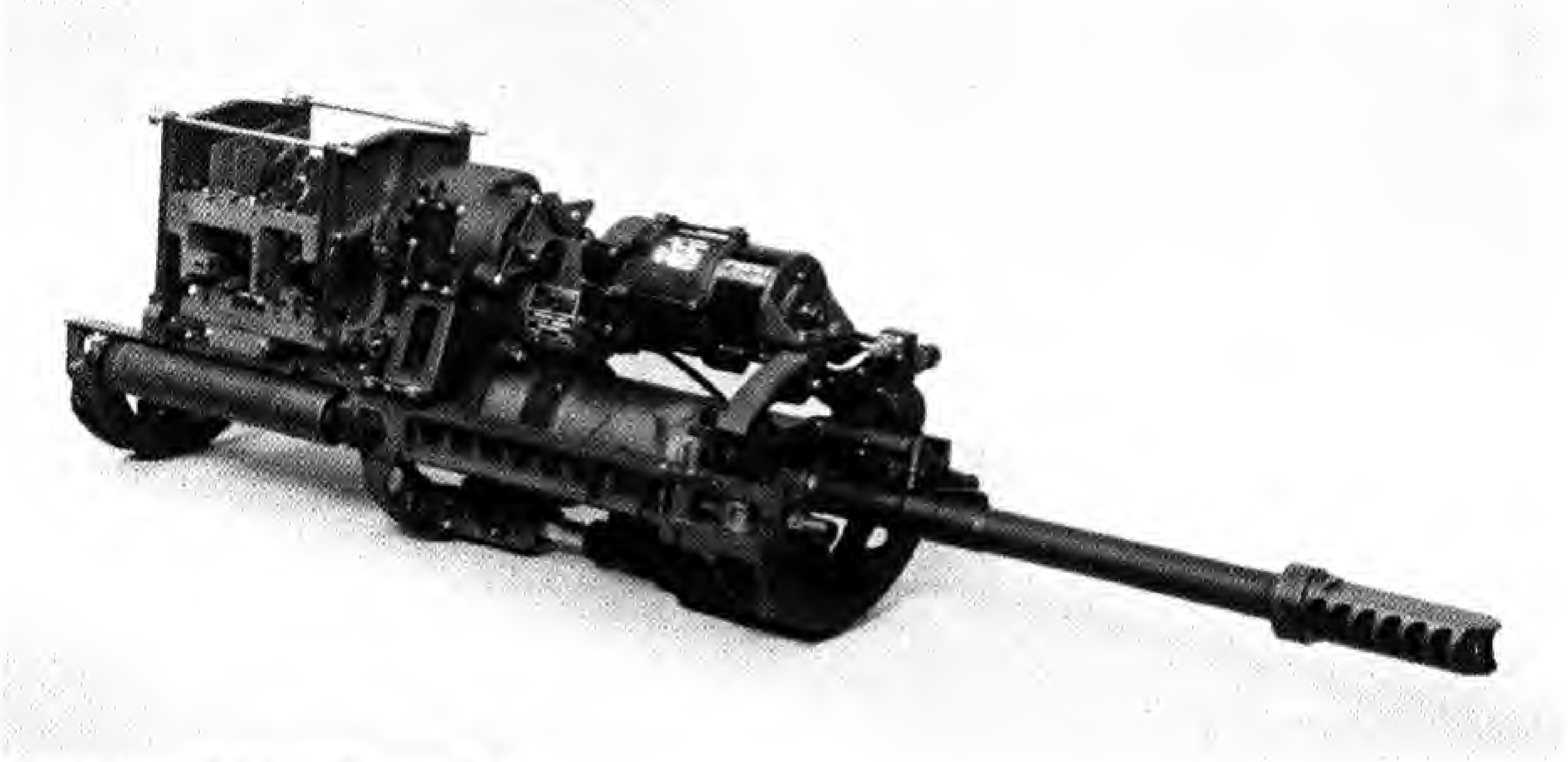
Breech Block. Breech Block with Locking Keys, Extractor, Slide and Striker.

Trigger Mechanism. Trigger Mechanism with Trigger and Sear. Housing is rigidly attached to the Breech Casing.

Cover. Cover with internal Feed Mechanism, Mounting Slide, Feed Tray and Ejector. The whole assembly slides on the Breech Casing. It is locked to the Cradle and does not recoil.

Chapter 28

30mm XM140 MACHINE GUN
PHILCO-FORD CORPORATION



30mm XM140 Automatic Machine Gun

History

The program for a 30mm area and point target weapon system originated in early 1963 with the release of technical characteristics by Headquarters, US Army Weapons Command.

A Springfield Armory firing test fixture with Picatinny Arsenal ammunition was designed as an entry in an independent evaluation by the Ballistics Research Laboratories at Aberdeen Proving Ground, Maryland. After a competitive evaluation with rockets and boosted projectile approaches entered by other government arsenals and commercial firms, the Springfield Armory approach was selected for continued development as the second generation area and point weapon system. The Springfield fixture was identified at different periods of the program as the Gun Type Aerial System (GTAS), the Area Point Weapon System (APWS), and the Weapons Command, 30mm (WECOM-30). The formal development of the weapon was initiated in June 1964 and identified as the XM140, 30mm automatic gun. The armament subsystem was identified as the XM30.

The subsystem was designed to replace the 2.75 inch rocket subsystem, XM3 and to fulfill the point target fire support mission for attack on personnel and lightly armored targets. The gun and ammunition were selected as the main armament for the Cheyenne, AH-56A.

Engineering and test plans were approved in January 1967 but weapon and ammunition development problems delayed the delivery of system hardware for Aberdeen Proving Ground Engineering Testing until September 1968. Continued problems suspended engineering testing until replacement weapons could be provided in April 1969. Additional modification of the subsystem and weapons delayed the restart of engineering testing until June 1969. The resumption of engineering testing was reoriented by the Army Material Command to apply engineering and service tests only to the XM140 gun and its family of ammunition with the UH-1C helicopter to be utilized as the aerial vehicle for parts of the revised engineering test plan.

Contract work on the XM140 weapon began at the Aeronutronic Division of Philco-Ford in 1967. The contracts were all from the U.S. Army Weapons Command.

During this weapon's development phase of the contract, 11 guns were built in 1967 and 16 were built in 1968. By 1969 a stage of limited production had been reached and 43 more weapons were delivered in that year.

Characteristics

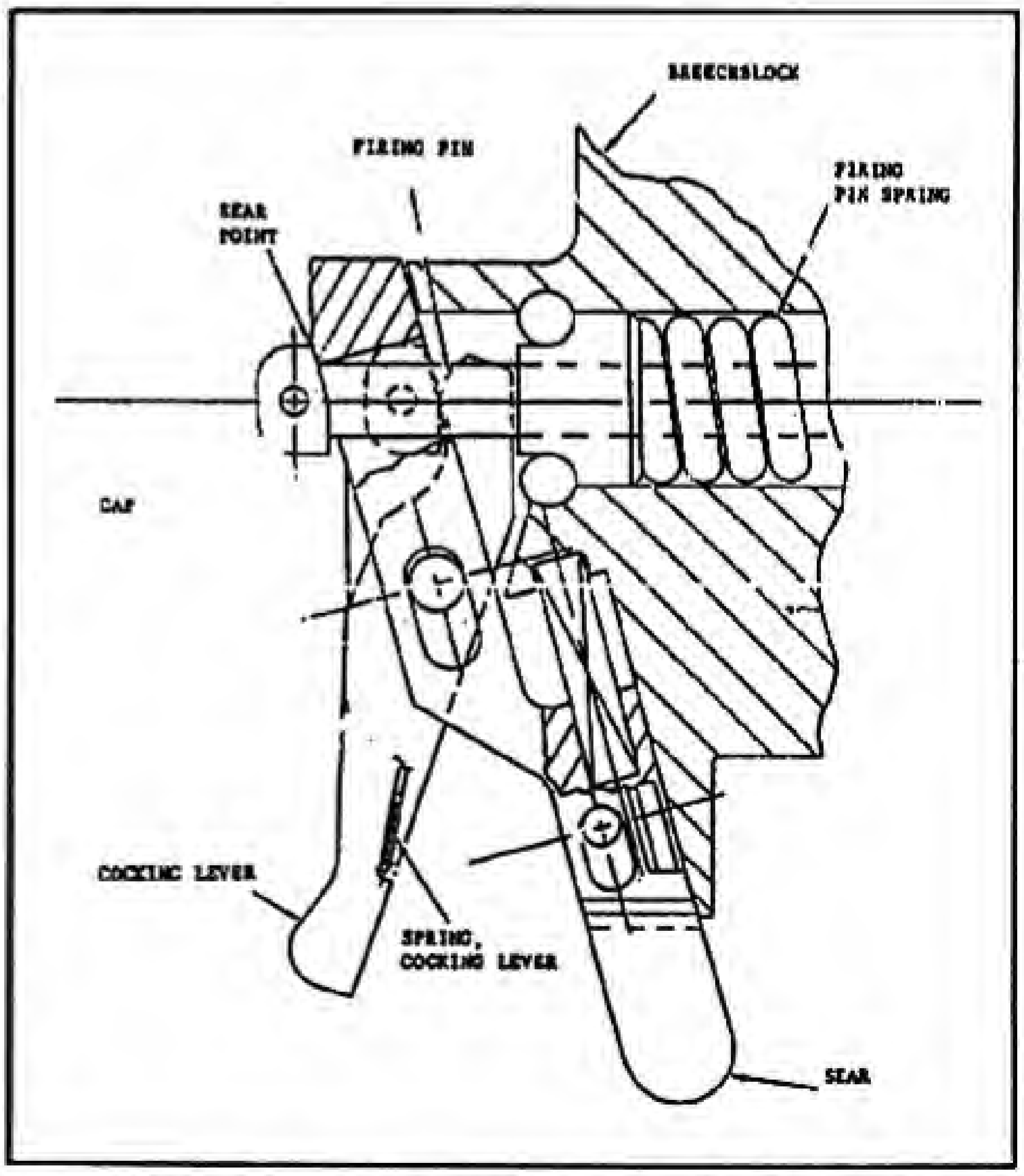
Bore Size	30mm
Muzzle Velocity	2200 fps
Rate of Fire	405 rpm
Basic Systems of Operation	recoil
Locking System	cammed
Power Source Feed System	power driven
Feed System	sprocket type
Type of Feed (location)	link right hand feed
Method of Chambering	mechanical control
Type of Receiver	machined
Weapon by Source	electro-mechanical
Manufacturer	Philco-Ford
Ammunition	XM552, XM554, XM639
Performance Data (Range)	3,000 meters
Miscellaneous	Formerly WECOM 30mm
Overall:	
Length	60.5 in. (maximum)
Width	12.3 in.
Height	14.5 in.
Weight	140 lbs.
Barrel Dimensions:	
Length	42 in.
Grooves:	
Number	16
Twist	0° to 4° 45
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Electro-Mechanical

The basic reason for the development of this particular weapon was to arm the Cheyenne Helicopter, however, it has been used in two armament subsystems, the belly turret for the AH-56A Helicopter, and the nose turret for the AH-1G Helicopter.

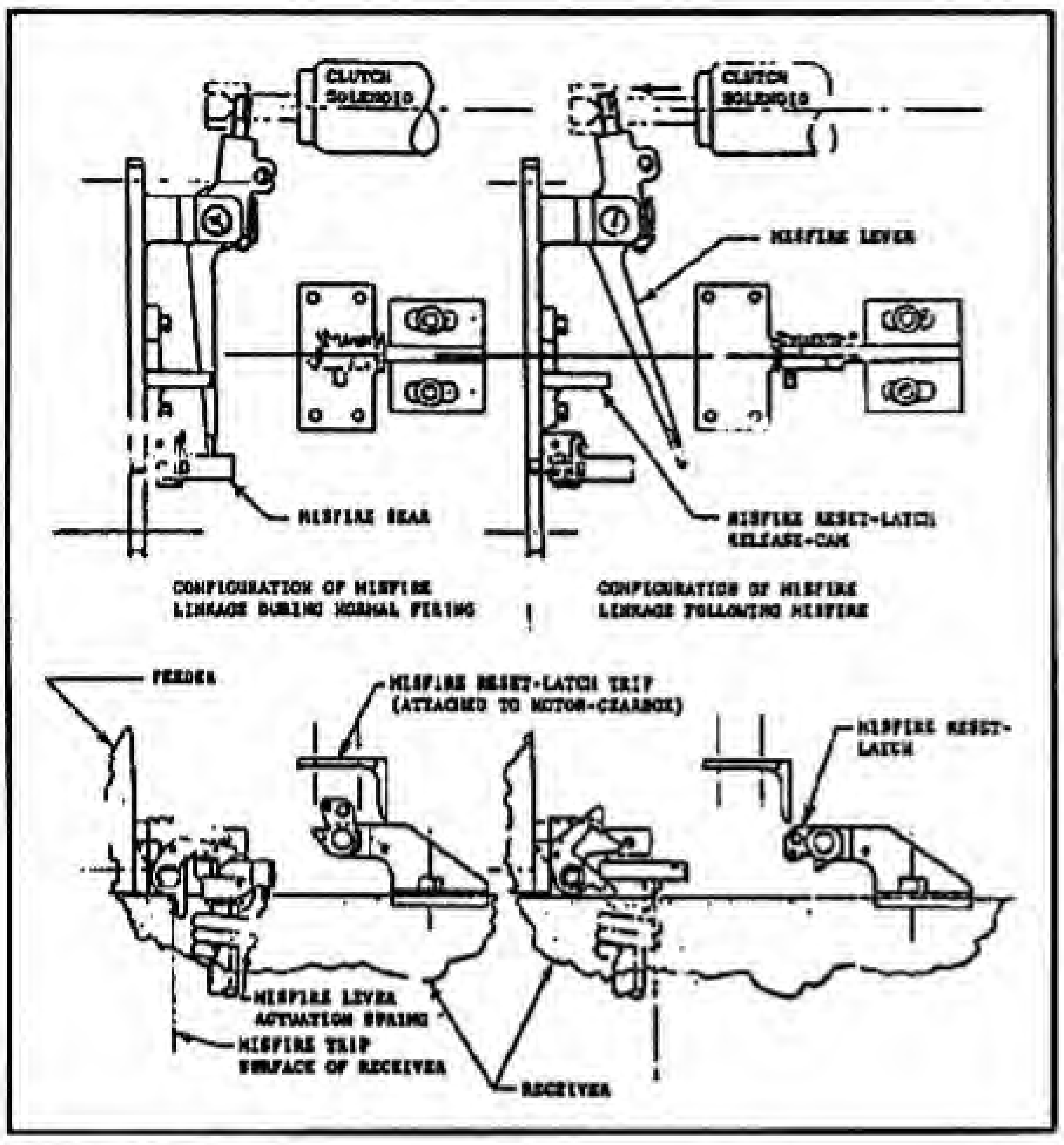
By mid-1972, over 620,000 rounds had been fired in the XM140 program and work was proceeding on increasing projectile weight and muzzle velocity, increasing reliability and decreasing maintenance time.

Description and Purpose

The XM140 is a lightweight, 30mm weapon, electrically driven and utilizing a fixed breech and single reciprocating barrel driven by a drum cam assembly concentric to the barrel. The receiver, barrel, drum cam and breechblock assemblies are components of the recoiling mass. The receiver comprising the non-recoiling mass are the feeder, mount, motor, and clutch, and charger assemblies. The drum cam assembly imparts reciprocating motion to the barrel assembly, which performs the locking, firing, and shell ejecting operations. The gun is timed to fire during the forward motion of the recoiling mass,



Breechblock Assembly (Increased Firing Pin Spring Energy)


CLUTCH SOLENOID
CLUTCH SOLENOID
MISFIRE LEVER
MISFIRE SEAR
MISFIRE RESET-LATCH RELEASE-CAM
CONFIGURATION OF MISFIRE LINKAGE DURING NORMAL FIRING
CONFIGURATION OF MISFIRE LINKAGE FOLLOWING MISFIRE
FEEDER
MISFIRE RESET-LATCH TRIP (ATTACHED TO MOTOR-GEARBOX)
MISFIRE RESET-LATCH
MISFIRE LEVER ACTUATION SPRING
MISFIRE TRIP SURFACE OF RECEIVER
RECEIVER

Misfire Mechanism

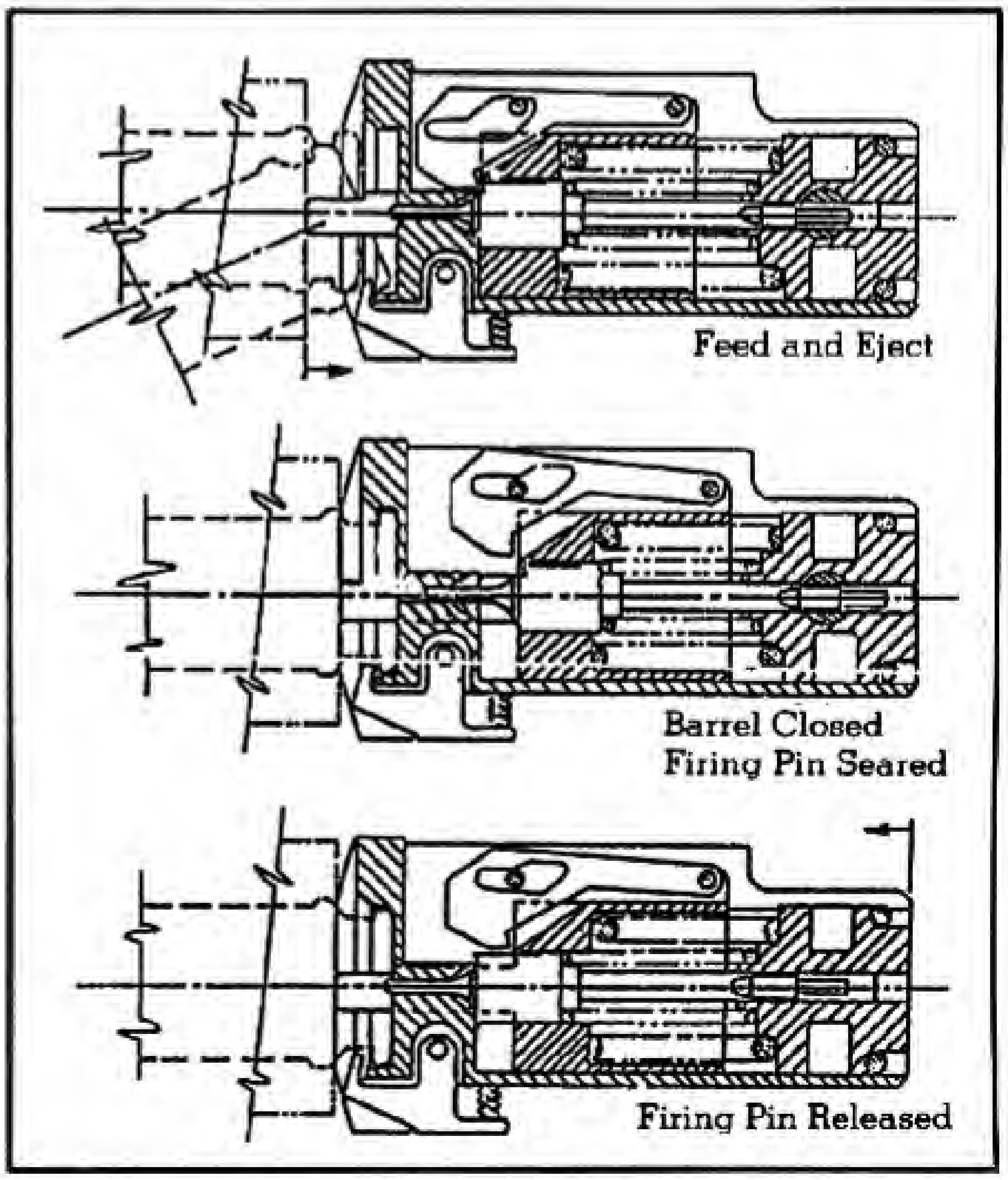
which provides a partial cancellation of forces between the gun and mount. Provisions are made for the gun to automatically eject a round, recharge, and resear itself for firing in the event of a misfire.

The purpose of the weapon is to provide area suppressive and point fire capabilities for helicopters and light aircraft against light armored vehicles and infantry.

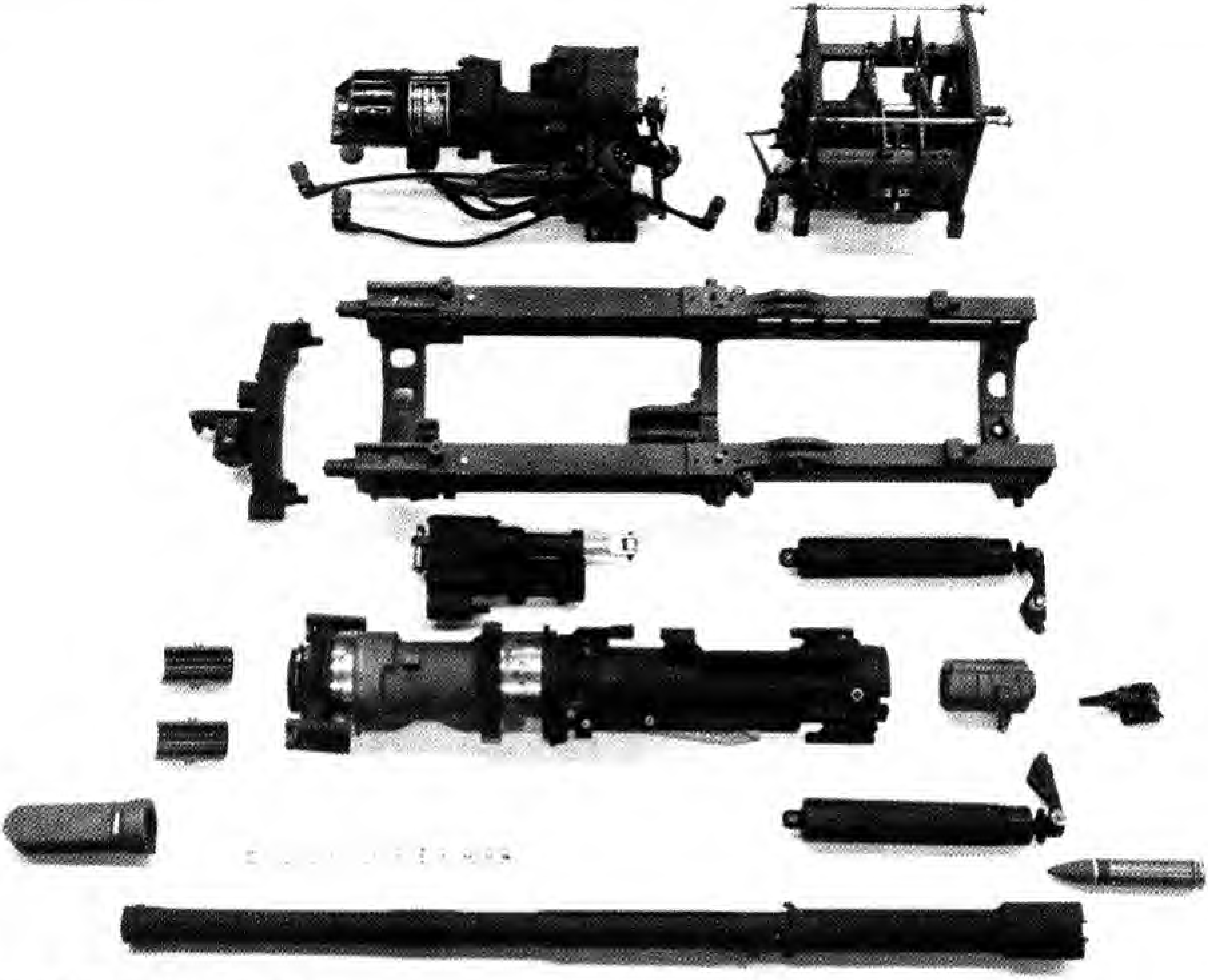
The gun is remotely controlled and powered by a 28V DC power source. Nominal rate of fire is 405 rpm with muzzle velocity of 2200 fps. The rate of fire will vary directly as the voltage varies.

Cycle of Operation

With the feed system loaded and the gun seared, the following sequence of events occurs when the trigger is depressed. The motor starts the barrel reciprocating through a spline gear, drum cam, and cam follower. When the motor gets to operating speed, the feeder solenoid engages the feeder clutch. As the barrel moves forward out of battery during the first rotation of the drum cam, a round begins to feed into the barrel's chamber. A proximity switch in the feeder sends a signal to the sear solenoid which positions it's release by a cam on the barrel. After the barrel has traveled forward a sufficient distance, the holding pawls are cammed into position, and along with the control springs underneath the feeder, positions with the round for chambering. The barrel closes rearward over the round on the second rotation of the drum cam. In the last 0.4 inches of travel, the base of the round forces the extractor down, makes contact with the ejector pins compressing the ejector and firing pin springs, thereby completing the firing pin cocking. Headspace is controlled by engraving of the barrel headspace pins into the round stop band on the cartridge case. When the barrel is 0.24 inches out of battery, the sear release lever is actuated by the barrel cam and the recoiling mass is forced forward under the spring load of the recoil forces. The barrel is locked to the breech during this third rotation of the drum cam by the locking plate in the drum cam. As the recoiling mass moves forward, the firing pin sear is released by a cam on the frame. The impulse of the round during firing forces the recoiling mass rearward to an oversear position allowing relatching of the sears. When the barrel is unlocked, the residual pressure in the chamber is at a safe level. As the barrel moves forward, the sear release lever is cammed away from the center of the barrel for a new cycle. The case is extracted and ejected. The ejector, besides ejecting the case, repositions the firing pin sear. The cycle repeats as long as the trigger is depressed.


Feed and Eject
Barrel Closed
Firing Pin Seared
Firing Pin Released

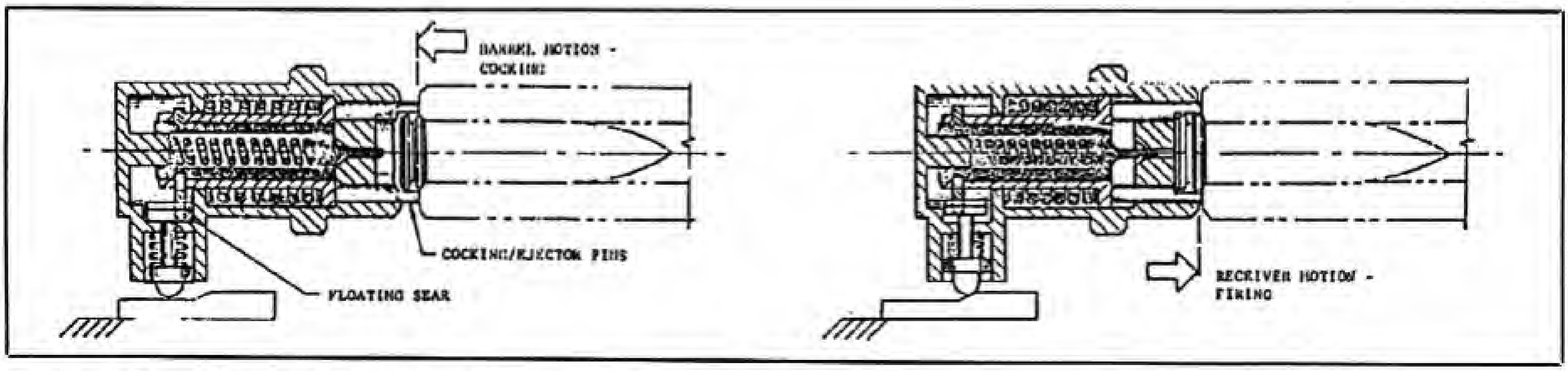
Barrel Operated Breechblock Concept Sequence of Operation



30mm XM140E3 Automatic Weapon

After the trigger is released, there is a 350 milliseconds delay before the motor is shut off. This delay allows the feeder to declutch and assures that a round is not in the chamber.

During a misfire the recoil drives the recoiling mass beyond the normal turnaround point, thereby mechanically tripping the misfire mechanism. The coil spring in the misfire mechanism declutches the


BARREL MOTION - COCKING
COCKING/EJECTOR PINS
FLOATING SEAR
RECEIVER MOTION - FIRING

Alternate Barrel Operated Breechblock Concept feeder. The drum cam continues rotating and ejects the misfired round. A misfire switch in the control mechanism and an electronic delay then recharges the gun to the seared position for repeating the firing cycle.

Ammunition

The XM140 Machine Gun fires the 30mm cartridge XM552, which is a high explosive, dual-purpose round. This cartridge, developed by the Army at Picatinny Arsenal in 1965, has a nominal muzzle velocity of approximately 2,200 feet per second. The round is equipped with a combination shapped charge/fragmentation projectile with a specified minimum range of 2,500 meters and an elevation angle of six degrees or less at aircraft speeds of 100 knots. The round is approximately seven inches long and weighs nine-tenths of a pound. It has a brass case with percussion primer.

30mm XM140 Ammunition developed by Picatinny Arsenal in 1965. (Photo courtesy of Woodin Laboratories).

Chapter 29

25mm TRW-6425 AUTOMATIC CANNON

TRW, INC.

25mm Automatic Cannon, TRW-6425, TRW, Inc.

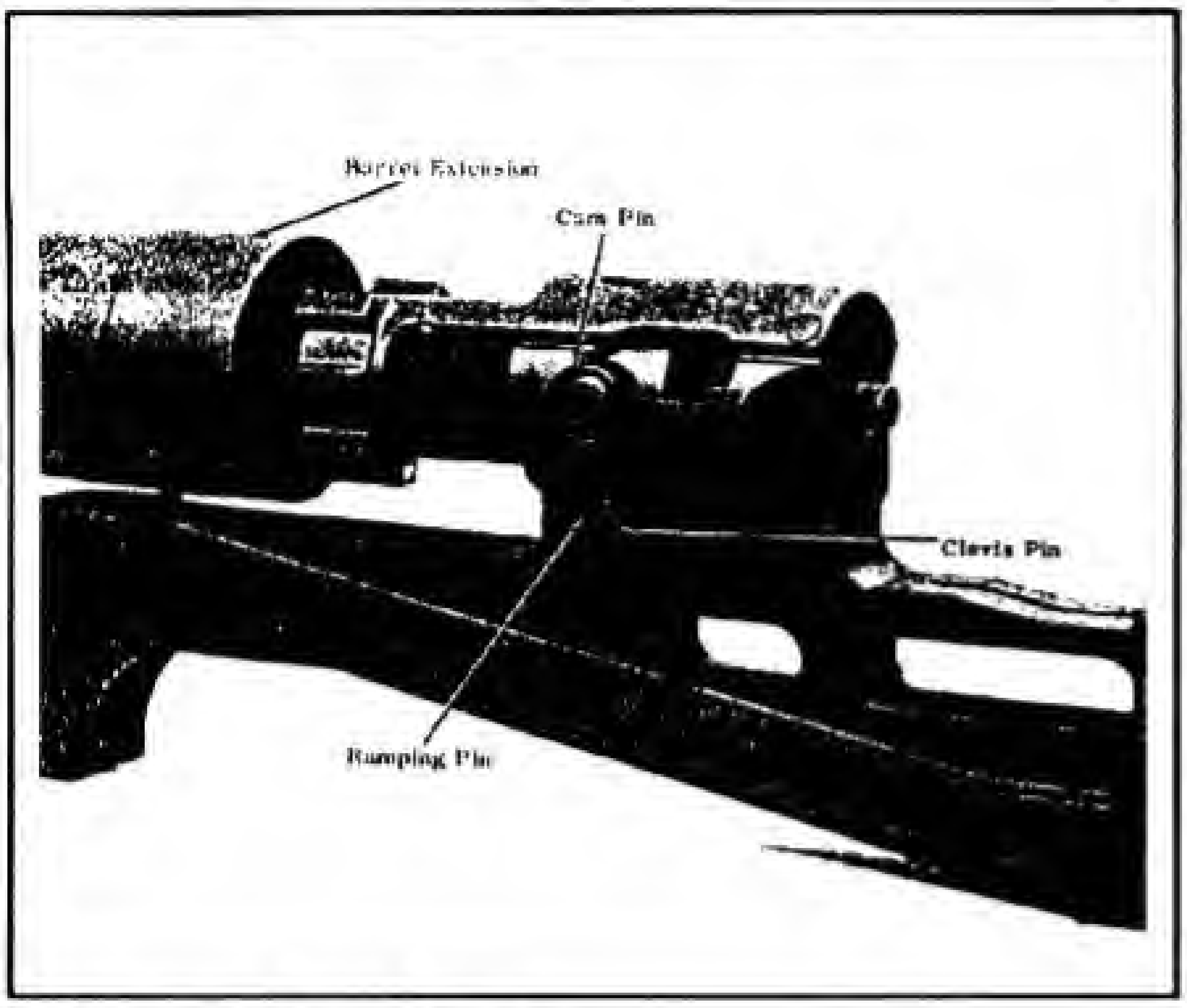
History

In early 1964 Thompson, Ramo, and Wooldridge, Inc. began work on their 25mm automatic cannon, known officially as the TRW-6425. Eugene Stoner served as a consultant and the weapon is considered to be of Stoner design and was specifically made to meet or exceed the requirements for the Vehicle Rapid Fire Weapons System, which is better known as the Bushmaster. The weapon concept was funded by TRW at least through the initial stages. Ammunition development was done primarily by Oerlikon. The first prototype was produced in 22 months and began test firing in November 1965 from an M114 vehicle. In December the prototype was fired from an Austrian Armored Personnel Carrier.

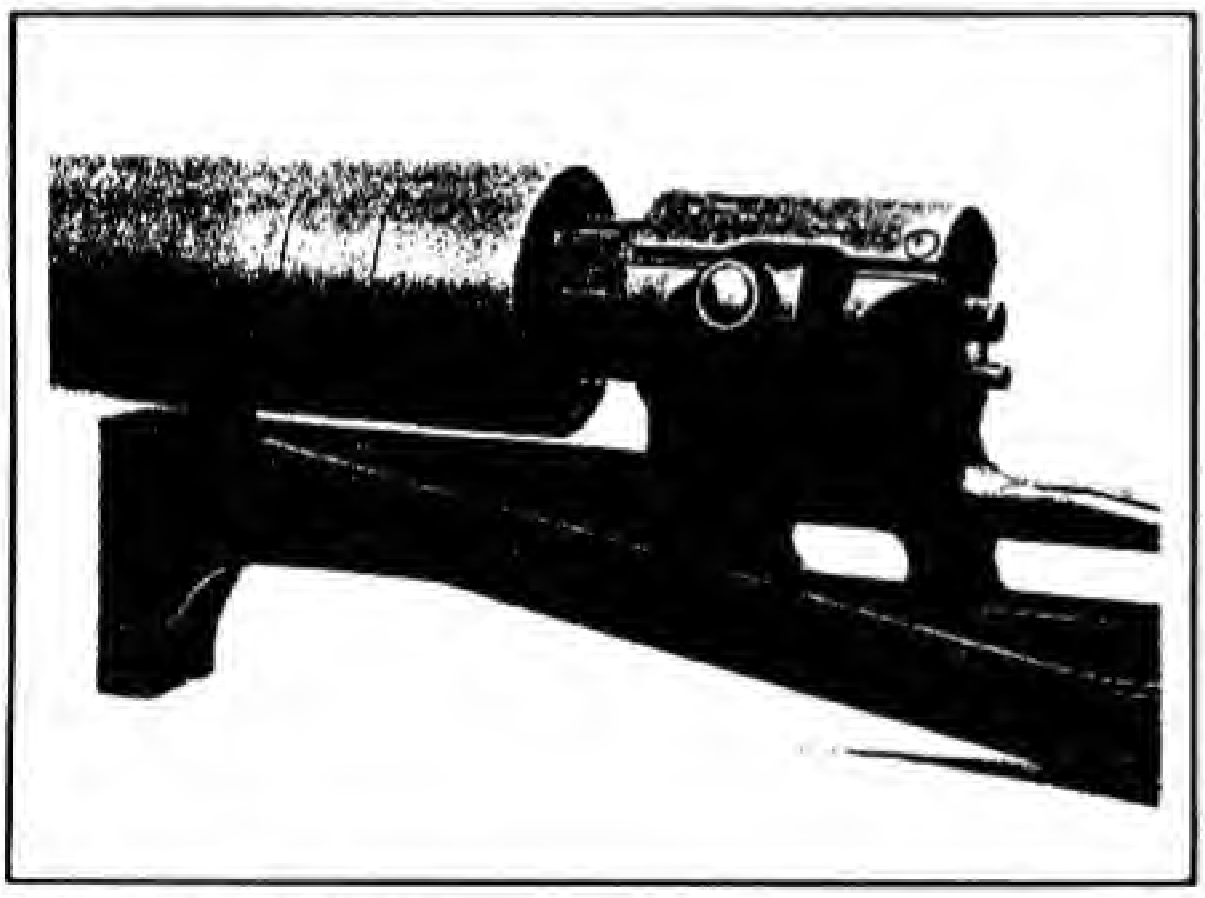
An early version was tested by a number of countries including Great Britain and France.

The early configuration was tested several times at Aberdeen Proving Ground. Included was a Military Potential Test from March 1968 to March 1970,

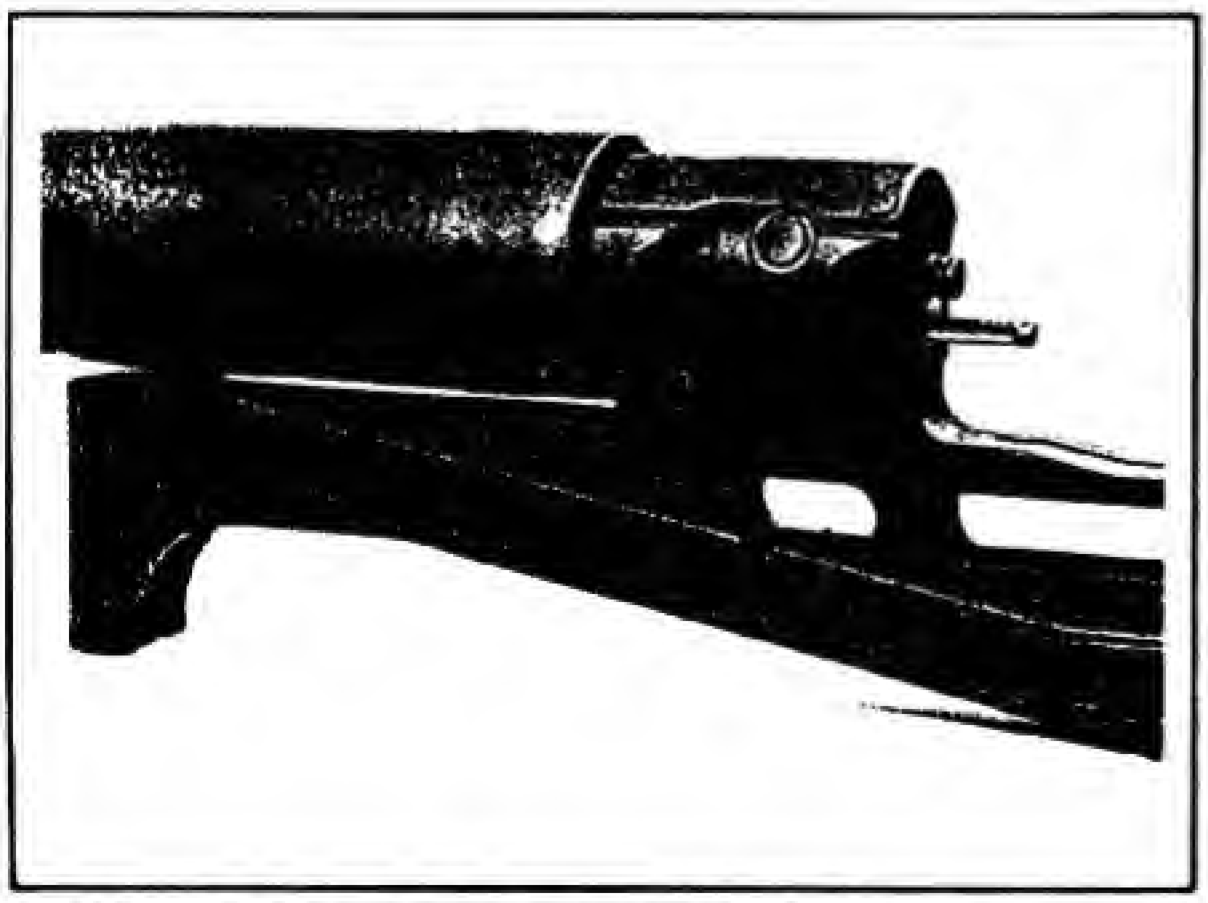
Three Positions of Bolt Locking



Bolt Entering Barrel Position



Bolt Rotated Halfway



Bolt Completly Locked. Carrier in Battery Position

and a Kinematic Analysis completed in early 1973.

Before the U.S. tests were completed, however, Philco-Ford acquired all rights to the TRW-6425. TRW ceased work on the gun in 1969. Since then, Philco-Ford has further developed their version, the PFB-25 and Oerlikon has fabricated the KB series which is similar to the 25mm cannon TRW-6425. Oerlikon then cooperated with Philco-Ford on ammunition for the PFB-25.

At least six TRW-6425 automatic cannons were built.

Description and Purpose

The TRW-6425 25mm automatic cannon was originally designed to fill the need for a vehicle mounted weapon capable of defeating light armored vehicles. The weapon was specifically designed to out perform the Interim VRFWS (VRFWS-1) gun, and the 20mm M139 (HS 820).

The rate of fire is 550 rounds per minute and an electrical control offers the options of several lower rates including semi-automatic operation. The weapon fires from the open bolt position and the sear is activated by a solenoid.

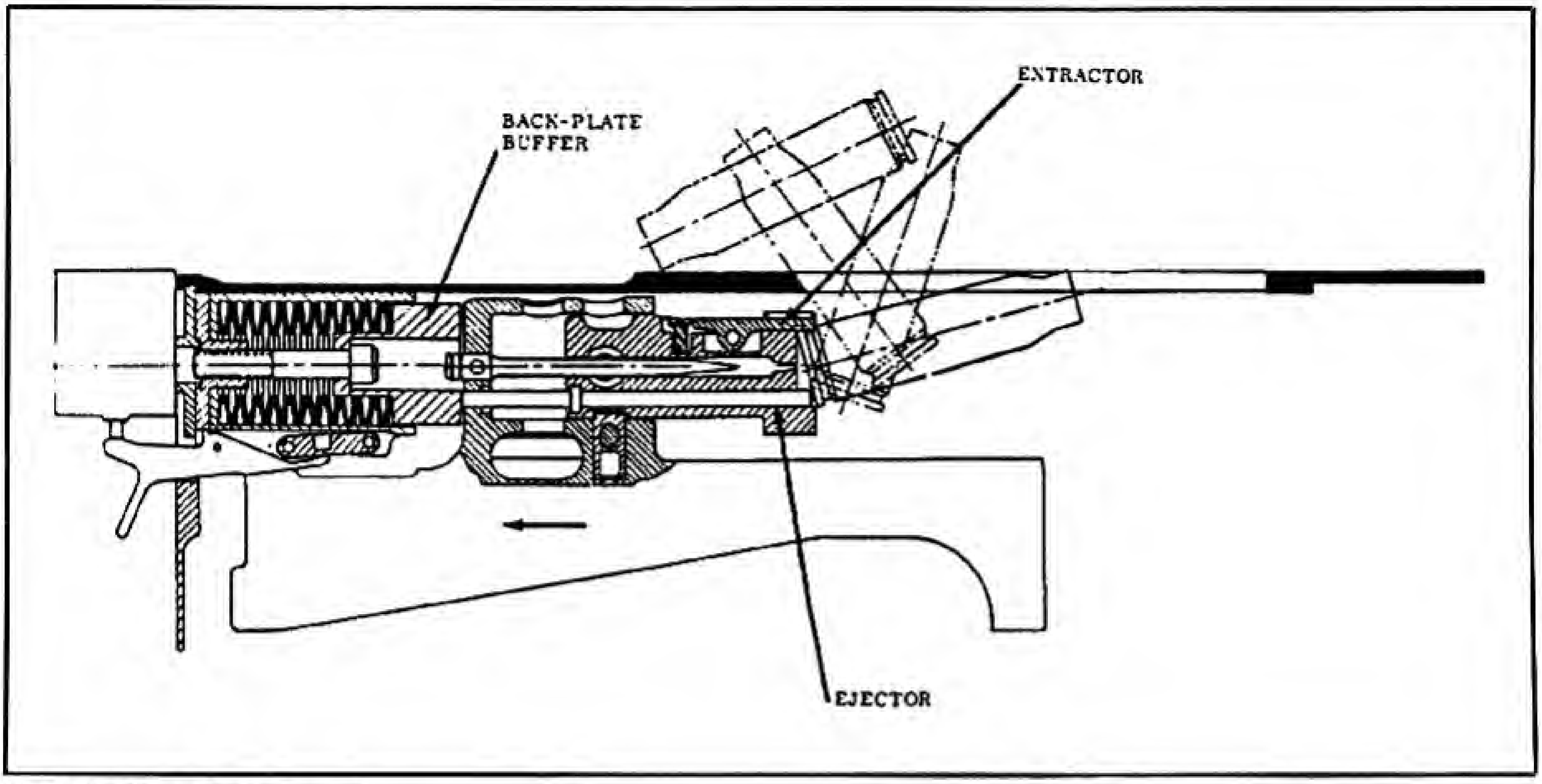
Cycle of Operation

The cycle of operation is divided into nine steps: stripping, chambering, locking, firing, unlocking, extracting, ejecting, feeding, and searing.

With one feeder containing the linked belt of ammunition locked against the receiver and the first round in position, the following cycle of operation takes place:

Chambering. Chambering occurs when a round is rammed into the chamber by the bolt. Chambering is completed when the round is fully seated in the chamber and the extractor snaps into the extracting groove of the cartridge.

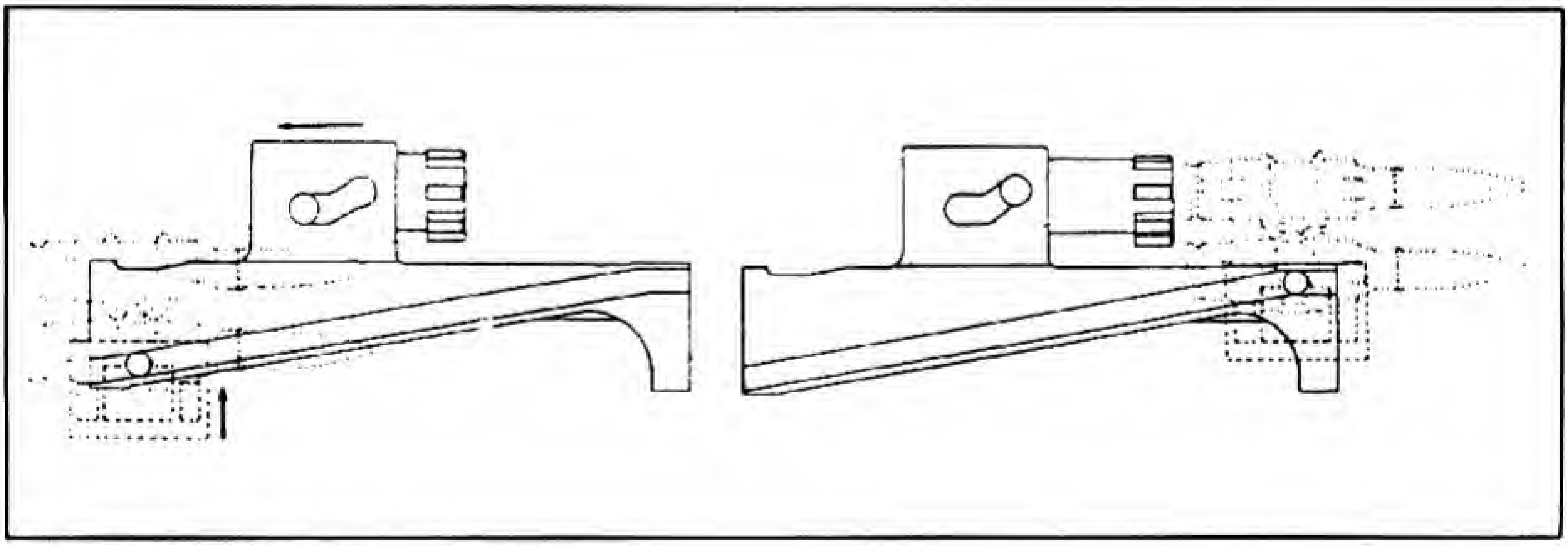
Extracting. Extracting is accomplished by the extractor located on the top side of the bolt. Hooked in the extraction groove of the cartridge case, it pulls the empty cartridge case from the chamber as the bolt moves to the rear.



Cartridge Case Being Ejected

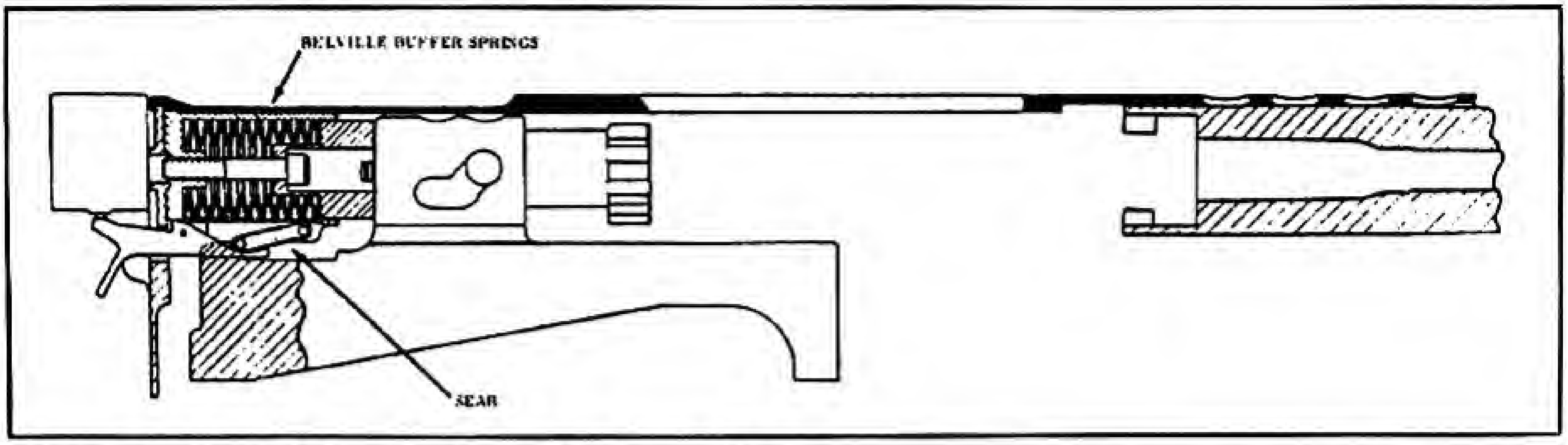
Ejecting. Ejecting is accomplished when the empty cartridge case is thrown clear of the receiver. As the bolt moves to the rear carrying the empty cartridge case, the floating ejector, which is located through the bolt, strikes the back-plate buffer housing. The ejector then forces the cartridge case to pivot about the extractor and the case is thrown out through the ejection port on the top side of the receiver.

The links are ejected out of the feed tray during the feeding stroke of the cycle.



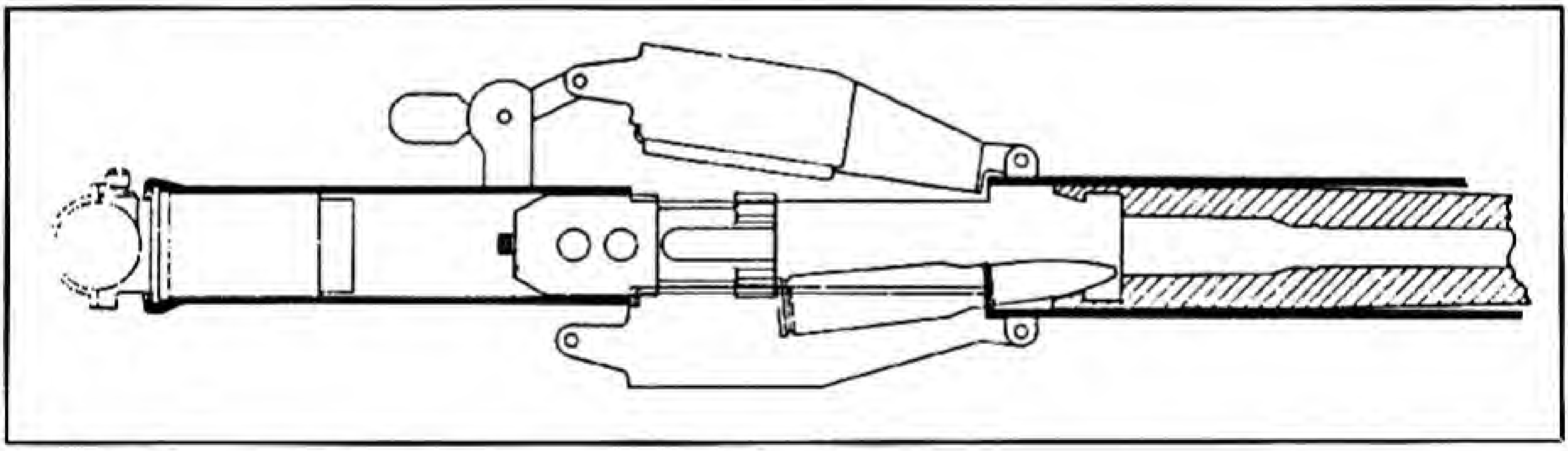
Feeding the Linked Round

Feeding. Feeding of subsequent linked rounds into the ready-to-strip position is accomplished during the rearward movement of the breech assembly. The same action takes place for either feeder. As the carrier moves rearward, the feed pawl assembly, located in slots on the side of the receiver, is moved upward in a direction 90° to the movement of the carrier because of the action of the carrier cam track on the roller of the feed pawl assembly. During this movement, the two spring-loaded feed pawls push against the link of the ammunition, projecting a round into the stripping position.

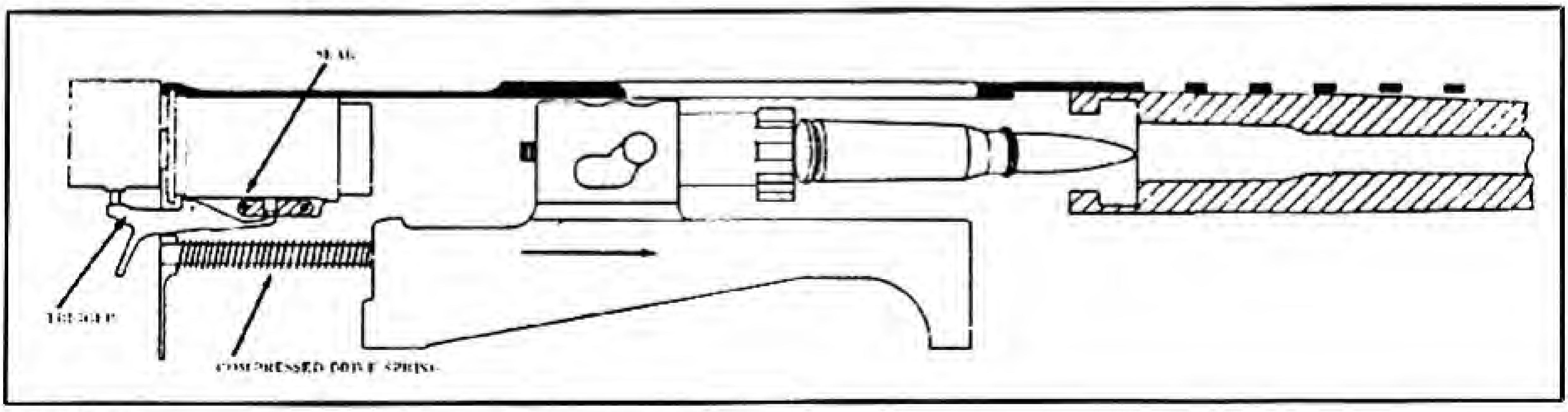


Carrier in the Seared Position, Sear Engaged in Recess of Carrier

Searing. Searing occurs when the breech assembly is held in its rear most position and is prevented from moving forward into battery. As the breech assembly impacts against the back-plate at the end of its rearward movement, it compresses the belleville buffer springs approximately 0.70 of an inch. At this point, if the trigger is not depressed, the sear is free to engage the carrier in the recess at the rear-top of the carrier. After compression of the buffer springs, the carrier rebounds from the back-plate but is prevented from moving forward since the sear is engaged in the carrier recess. The impact of the sear engaging the carrier is dampened out by the same buffer springs since the sear is attached to the buffer spring housing.



Top View

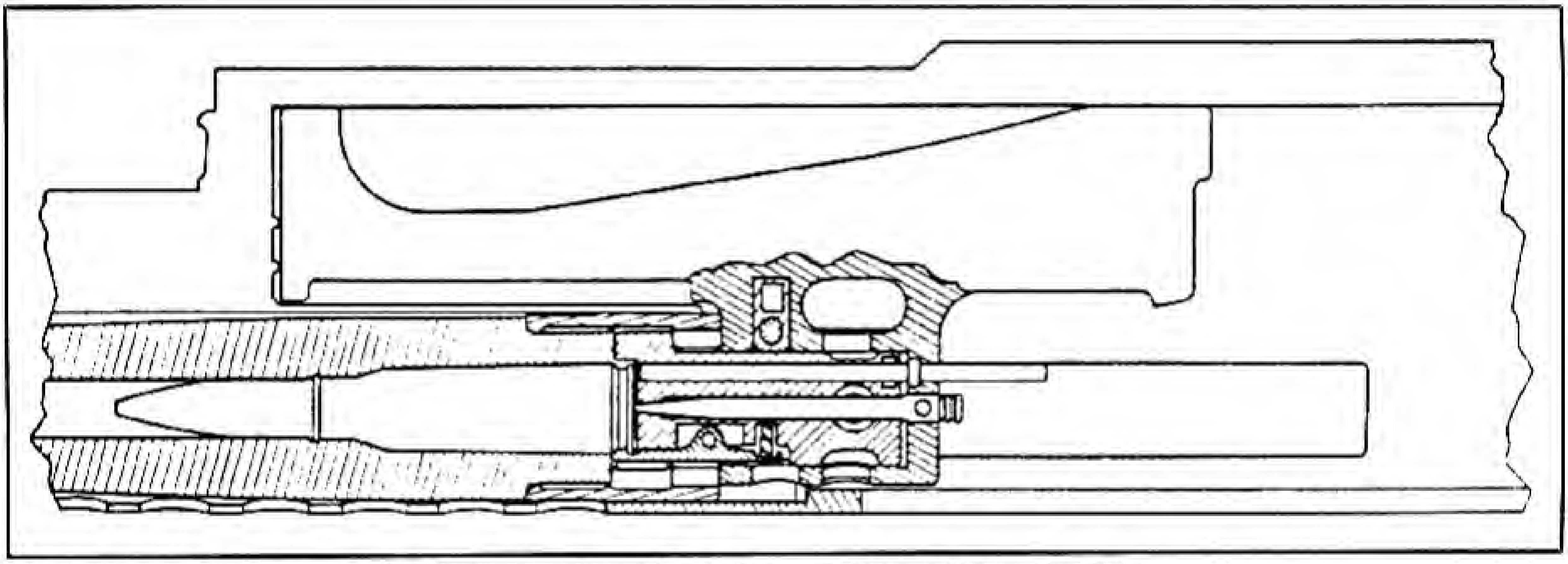


Side View

Stripping. When the electric solenoid is energized, the trigger moves the roller sear upward out of the recess in the bolt carrier. The breech assembly is thus free to be driven forward from the open-bolt position by the compressed drive spring. As the bolt moves forward, it strips the first round from its link in the feed tray and moves it toward the chamber.

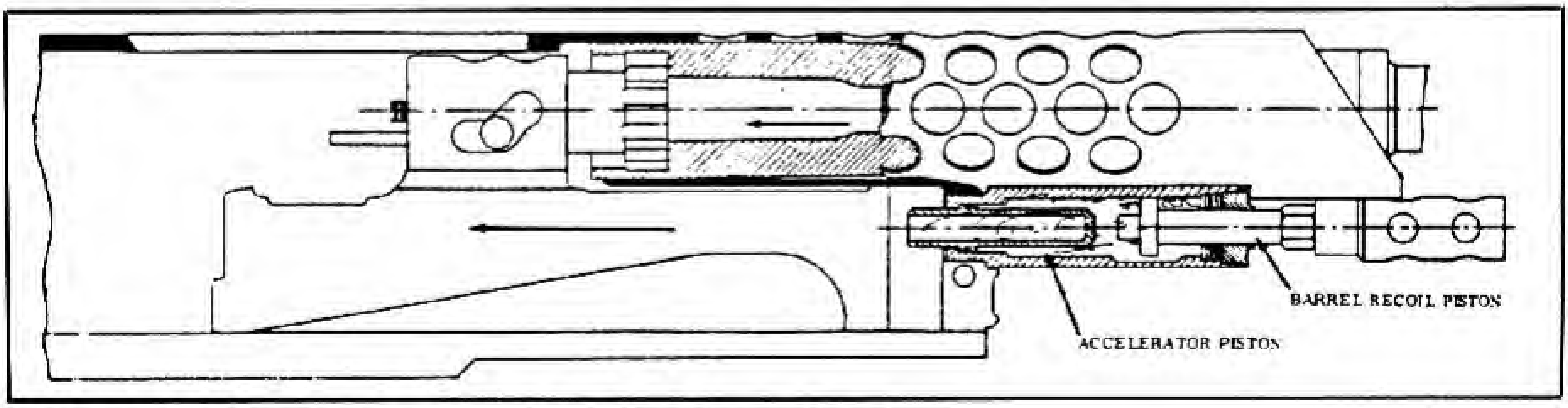
Locking. Locking occurs when the bolt is fully rotated into its locked position, so that the bolt lugs are directly in line with, and in front of the barrel extension lugs, preventing the bolt from moving to the rear when the weapon is fired.

Locking is accomplished when the bolt, carried forward by the bolt carrier, due to the action of the expanding drive spring, enters the barrel extension and is stopped by hitting the breech end of the barrel. The impact force is dampened through the action of the belleville buffer springs located in the accelerator assembly. Prior to this, the bolt was prevented from rotating because it had been contained by the clevis pin - ramping pin combination recessed in the underside of the bolt. The ramping pin rides on tracks located in both sides of the receiver throughout the movement of the bolt carrier and at this point cams the clevis pin downward out of the bolt recess, thus allowing the bolt to rotate. The clevis pin-ramping pin combination prevents rotation of the bolt during stripping, therefore preventing firing pin protrusion until the bolt is fully locked in the barrel extension. The carrier continues to move forward. Because of the action of the carrier cam track on the cam pin, the bolt is rotated clockwise into its locked position, being fully locked when the carrier is still ¾″ from battery. The carrier continues on into battery.



Bolt Carrier in Battery, Firing Pin Protruding through Bolt, Igniting Primer, Firing Cartridge.

Firing. Firing takes place when the primer ignites the propellant charge in the chambered cartridge. The firing pin is fixed to the bolt carrier and moves with it. After the bolt is completely locked, the firing pin begins to protrude through the bolt as the carrier continues on into battery. At the instant the carrier has completed its forward movement, the firing pin protrusion is sufficient to ignite the primer in the chambered cartridge.

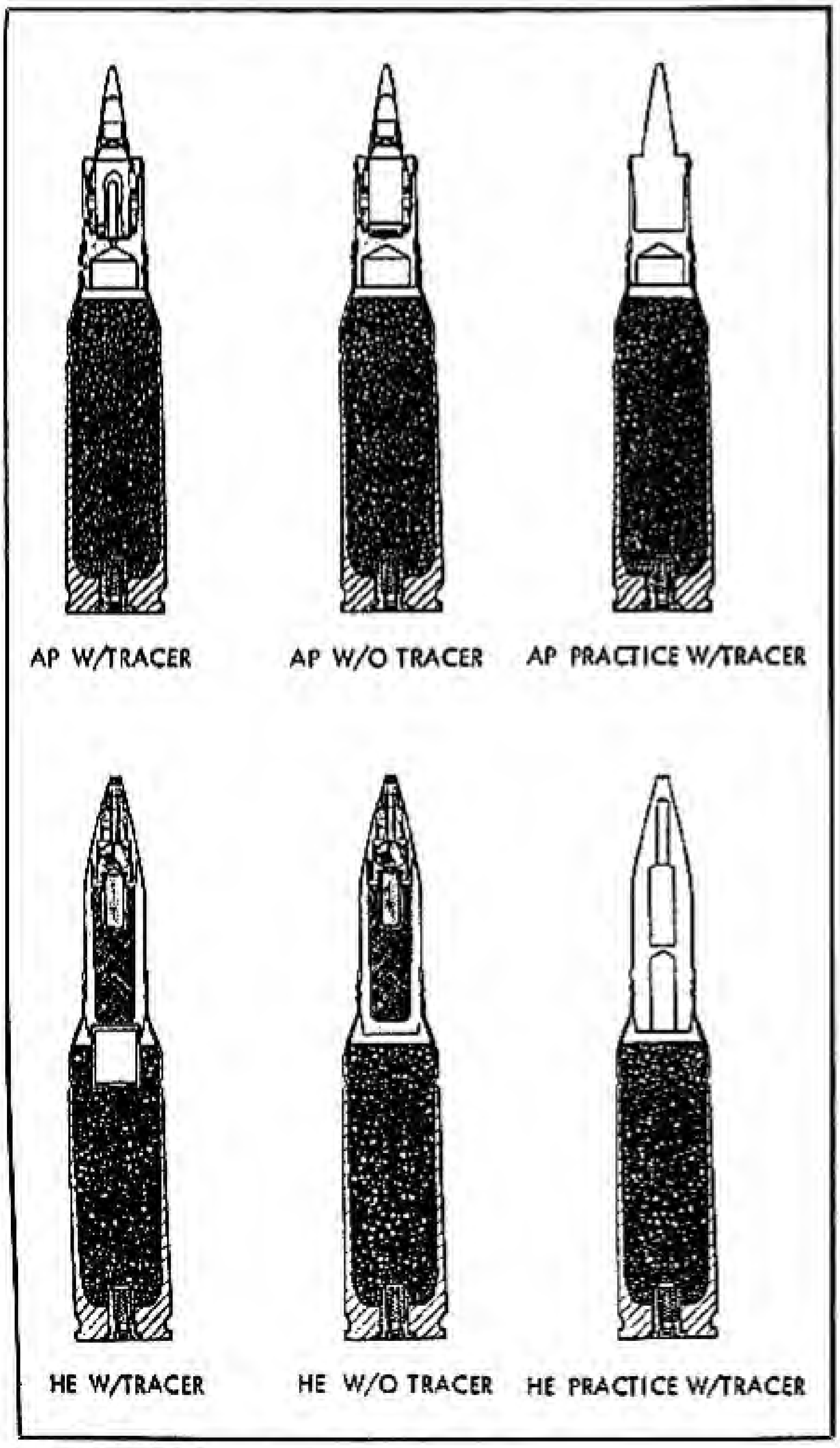


Bolt Starting to Unlock, Carrier Accelerated 1.5 times Velocity of Barrel.

Unlocking. As the projectile begins to travel down the bore of the barrel, the barrel and breech assembly begin to recoil within the receiver. The bolt carrier, however, is recoiling at a higher velocity than the barrel. This is accomplished through the action of the hydraulic accelerator which multiplies the carrier recoil velocity 1.5 times the velocity of the barrel assembly.

The barrel is attached to the barrel recoil piston located in the accelerator housing. During this phase of the recoil cycle, the bolt recoils with the barrel since it is still locked to the barrel extension. The cam pin, acted on by the carrier cam track, then rotates the bolt counter-clockwise until the bolt lugs are no longer in line with and in front of the barrel extension lugs.

The bolt is now completely unlocked and is free to travel to the rear. Complete unlocking occurs when the gas pressure has reached a safe level. There is, however, residual pressure which acts against the bolt face to assist the recoil of the breech assembly during its rearward movement.



TRW-6425 25mm Ammunition

The barrel recoil motion is dampened out within the accelerator assembly through the action of the hydrospring buffer. The barrel is then returned to the battery position by the compressed barrel recoil spring located within the accelerator assembly.

Automatic Fire. The gun will fire in an automatic mode if the trigger is depressed holding the sear in the upward position. This is accomplished through the electrical firing circuit by continuing to energize the firing solenoid. With the trigger depressed, the bolt carrier will rebound from the backplate buffer assembly and continue forward being propelled by the driving spring. The carrier continues its forward movement and the cycle of operation is repeated. During the forward movement, the link-belt of ammunition is held in place by two holding pawls located within the feed trays. Firing continues until the trigger is released or the ammunition supply is exhausted.

Test Results

The results of the Military Potential Test completed in 1970 at Aberdeen Proving Ground are given in this section with minor editing.

Summary. The purpose of the test was to determine the military potential of the Thompson-Ramo-Wooldridge 6425 weapon and metallic link. The test was conducted at Aberdeen Proving Ground between March 1968 and March 1970. Functioning, unlubricated, accuracy and dispersion, dust, rain, cold, belt pull, and link tests, mostly of limited scope, were conducted with one weapon from a gimbal-type test stand. High malfunction rates and a large number of part failures in most subtests indicated that in its current state of development the Thompson-Ramo-Wooldridge 6425 weapon is not sufficiently developed. The weapon shows military potential as demonstrated by its characteristics and successful modifications applied during the test. It is recommended that further development of the weapon be accomplished prior to any future testing.

Results. The test results are summarized as follows:

Average dispersion at 300 meters, employing three types of ammunition, ranged from vertical standard deviations of 3.3 in. to 18.9 in. and horizontal standard deviations of 3.2 in. to 32.3 in. Average dispersion results recorded at 1,000 meters ranged from vertical standard deviations of 14.7 in. to 92.2 in. and horizontal standard deviations of 11.5 in. to 68.8 in.

Chapter 30

20mm Mk 20 Rh 202 MACHINE CANNON
RHEINMETALL

20mm Mk 20 Rh 202 Machine Cannon

History

The Rh 202 was the 20mm gun selected by West Germany in a competition held in 1965. The gun was adopted and has been in production since 1969. Over 6,000 units have been built and Germany, Switzerland, and Italy use the weapon.

The gun was demonstrated at Aberdeen in 1969 and was handled in the U.S. by Maremont for a short time. The Rh 202 underwent tests at Aberdeen in late 1974.

Description and Purpose

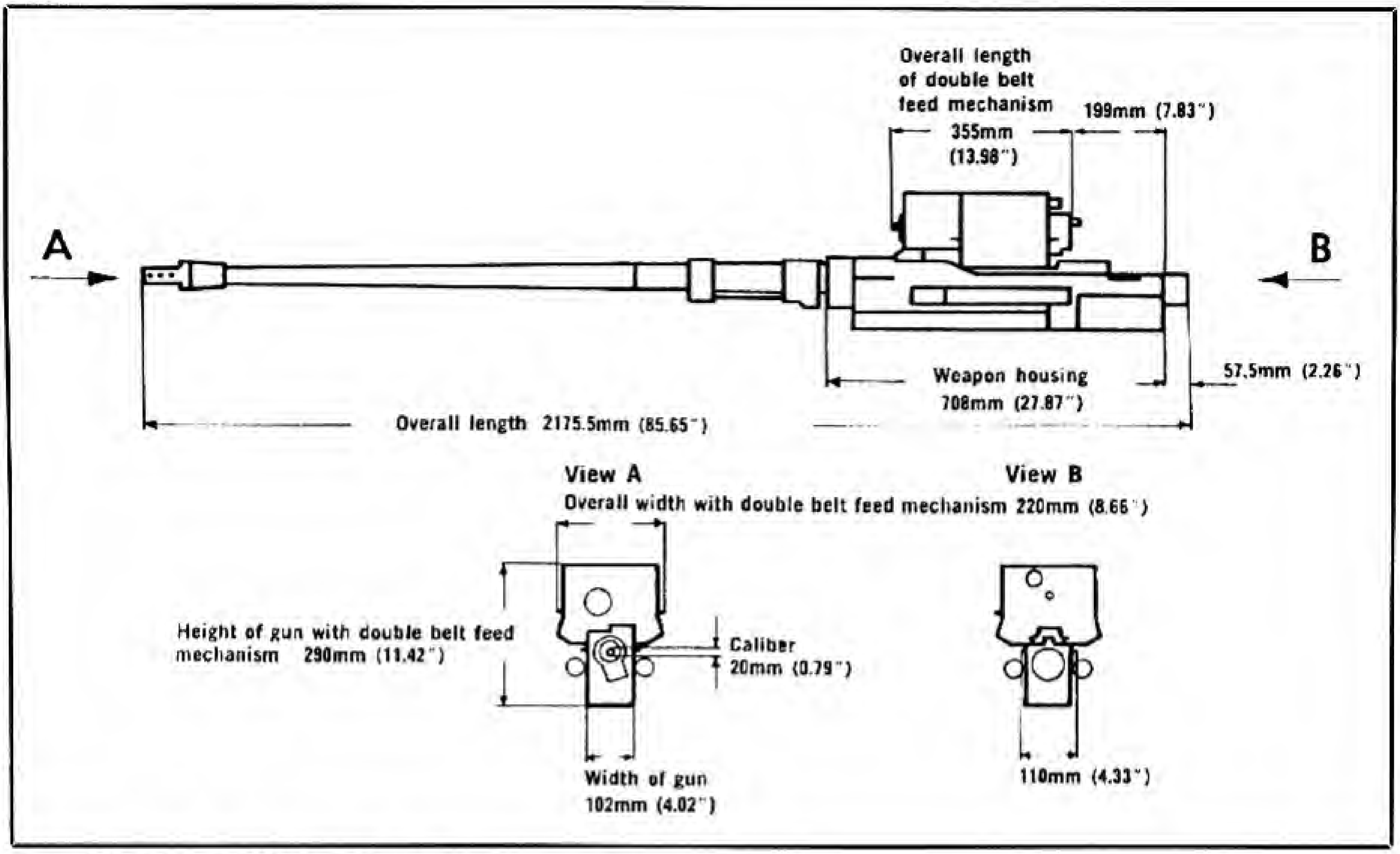
The Rh 202 is gas operated and has a rigid breech block. The bolt is locked by two symmetrically arranged locking pieces and fires unoiled ammunition at the rate of 800 of 1,000 rpm. Feed is from left, right or above, without change or addition of parts, permitting three types of ammunition. Low recoil forces of 1,125 to 1,570 pounds and a muzzle brake permit installation of the Rh 202 in a variety of light weight mounts of simple design. The weapon can be maintained by one man.

The Rh 202 is available in four different designs. Its German designations and design features are as follows:

Mk 20 DM2: Barrel with 6° rifling angle and two-way belt feed
Mk 20 DM3: Barrel with 5° rifling angle and two-way belt feed
Mk 20 DM4: Barrel with 5° rifling angle and three-way belt feed
Mk 20 DM5: Barrel with 6° rifling angle and three-way belt feed

The Rh 202 is used to engage ground, flying and sea targets as a weapon which is installed in armoured and unarmoured vehicles, field and ship mounts, helicopters, and combat aircraft.

The projectile fired from barrels with a 5° rifling angle reach a lower maximum velocity, therefore minimum time required for self-destruction is shor-


Overall length
of double belt
feed mechanism
355mm
(13.98")
199mm (7.83")
A
B
Weapon housing
708mm (27.87")
57.5mm (2.26")
Overall length 2175.5mm (85.65")
View A
View B
Overall width with double belt feed mechanism 220mm (8.66")
Height of gun with double belt feed
mechanism 290mm (11.42")
Caliber
20mm (0.79")
Width of gun
102mm (4.02")
110mm (4.33")

20mm Mk 20 Rh 202 Machine Cannon

ter than those fired from barrels with a 6° rifling angle. Therefore, barrels with a rifling angle of 5° are used in weapons which are primarily intended for the engagement of air targets. Barrels with a rifling angle of 6° are used in weapons which are primarily intended for ground combat and for firing over greater ranges and where the danger caused by ground detonations need not be taken into account.

The two way belt feed has two feeding slots which enables two ammunition belts to be inserted into its two feeding slots and a quick selection of ammunition. The three way belt feed allows the feed of ammunition in belts from the right, from the left and from the top as well as in belt frames or magazines, but only from the top. In contrast to the two way belt feed, each of the belt feeds can be loaded via only one of the feeder slots, the change from one feeder slot to one of the other two by means of some manual operations.

The gas pressure generated during firing causes the unlocking and recoiling of the breechblock with the simultaneous release and ejection of the cartridge case, the tensioning of the locking springs and the tensioning of the driving springs of the belt feed.

Characteristics

Weapon:	
Length	102.8 in.
Width	7.5 in.
Height	10.1 in.
Weight, with two-way belt feed	165 lb.
with three-way belt feed	178 lb.
Barrel:	
Length with Muzzle Brake	79.5 in.
Length without Muzzle Brake	72.4 in.
Receiver:	
Length	29.9 in.
Width	4.3 in.
Height	6.9 in.
Weight	46 lb.
Performance:	
Muzzle Velocity with explosive incendiary shell	max. 39.9 fps
Muzzle Velocity with hard core shell	max. 43.3 fps
Rate of Fire	800-1000 rounds/minute
Maximum Range	4.3 mi.
Best Combat Range	.74 mi.

Chamber flutes aid extraction. The belt movement is independent of the breechblock and weapon recoil.

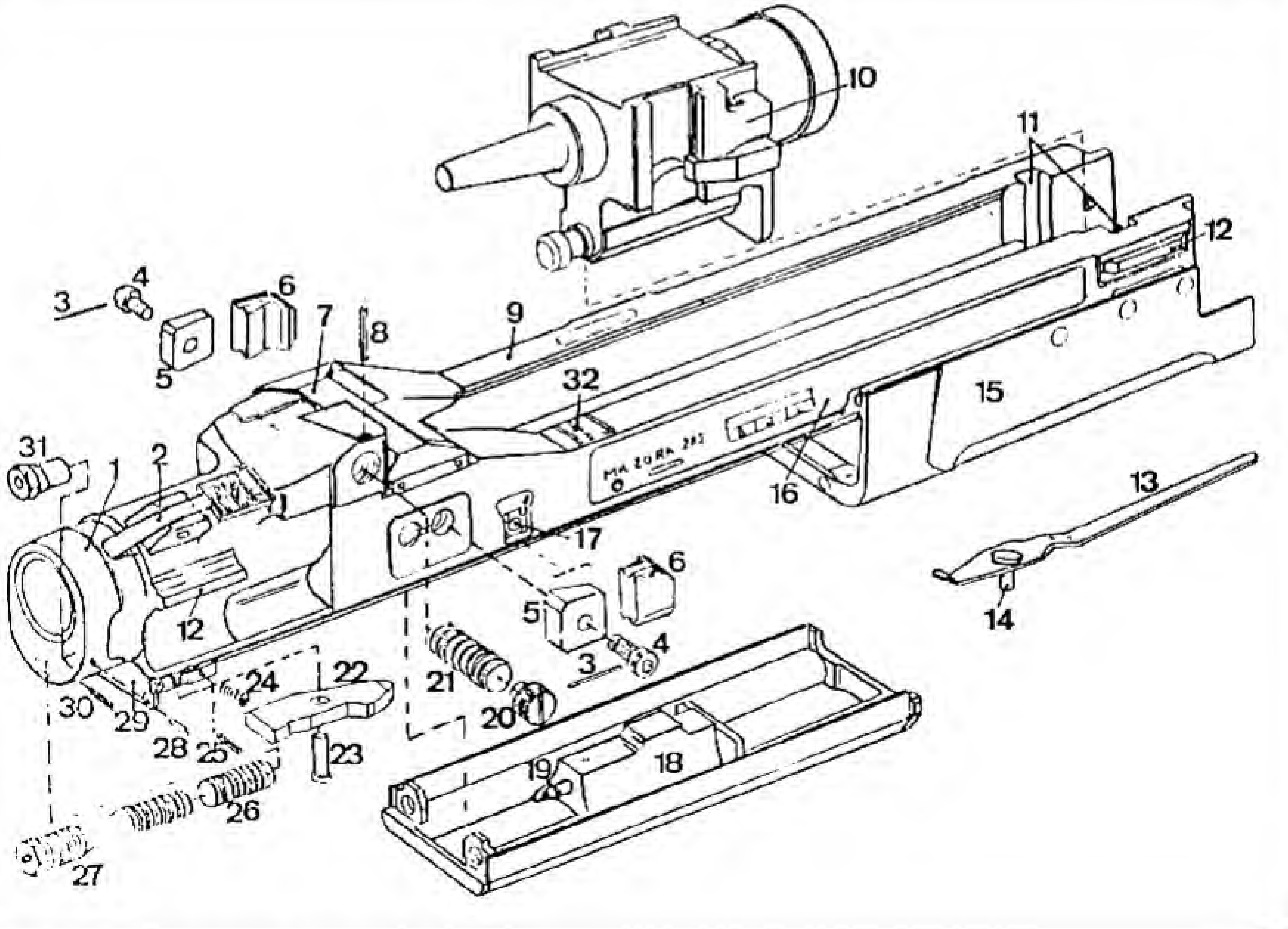
The weapon has a rigid breechblock, gas driven belt transport, a trigger mechanism which can be set to continuous and individual firing, a mechanical safety device against accidental firing, and automatic safeguarding of the breechblock catch lever against release by vibration.

Cycle of Operation

When activating the trigger lever, released via the firing linkage at the mount, the breechblock is released by the breech catch lever. Under the pressure of the closing springs, the breechblock jumps forward, pushes a cartridge from the belt feed with its feeder lug and inserts it into the chamber. The extractor claw will engage in the groove of the cartridge.

Prior to the termination of breechblock recuperation, the locking supports are swung aside by the controller into the recesses of the locking abutment and will then lie firmly against the locking abutments in the housing. This locks the breechblock to the weapon housing and releases the further path of the locking slide in relation to the breechblock. When the locking slide reaches its most forward position, the breech will be firmly locked and the cartridge will be pressed into the chamber.

About 9mm before the locking slide reaches its most forward position, the left-hand spring slide meets up with the retarding lever. The counterrecoil movement of the spring slide is thus being slowed down while the locking slide carries on the forward movement within the clearance between the follower lugs of the spring slide and those of the locking slide. This will prevent the latter's resiliency by means of the fact that the now slowed down spring slide moves forward within the clearance in the lugs, leaving the locking slide in its most forward position.



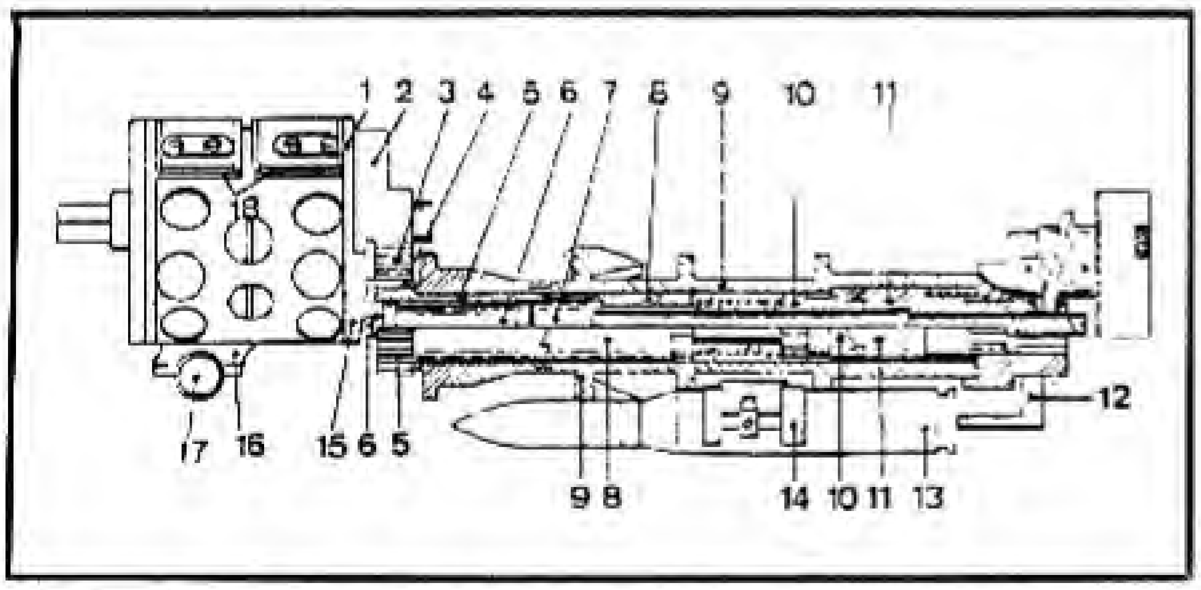
Weapon Housing, Buffer and Protective Frame

In this position, the cartridge is being primed by the striker. The gas pressure produced by the priming of the cartridge presses the round into the barrel at a high velocity.

As soon as the round has passed the gas bore in the barrel, the highly-stressed powder gases can pass through same into the gas channels, from there over the barrel nozzles and housing nozzles and will thus act on the gas piston for the belt feed drive. The pushed-back gas piston for the breechblock release meets up with the stop surface of the locking slide and pushes it back with the controller. The sliding back of the locking slide with controller and striker releases the locking supports and causes them to swing inwards. The breechblock is released and is flung rearwards by the cartridge case which is being pushed out of the chamber by gas pressure.

During the recoiling of the breech, the spring slides engaging with the locking slide by means of the follower lugs are also taken back and will tension the closing springs. Prior to the termination of recoil, the cartridge case will push against the two lugs of the ejector which is elastically supported in the mount, with the edge of the shell base, is turned around the extractor claw at a high velocity and is then ejected from the weapon downwards.

During the recoil movement, the closing springs are tensioned by the breech which will thus pass part of its recoil energy to them. Any inertia still available is taken up by the cup springs via the buffer, while the cup springs relief will again initiate the forward movement of the breech.



Mode of Operation of the Drive Mechanism of the Three-Way Belt Feed

1. Spring Housing
2. Limiting Stop
3. Toothed Segment
4. Intermediate Gear Wheel
5. Coupling Gear Wheel
6. Stem
7. Decoupling Bar
8. Coupling Bush
9. Transport Shaft
10. Stop
11. Locking Shaft
12. Probing Lever
13. Cartridge in Feeding Position
14. Empty Belt Link
15. Gearing Cam
16. Drive Attachment
17. Gas Piston
18. Drive Springs

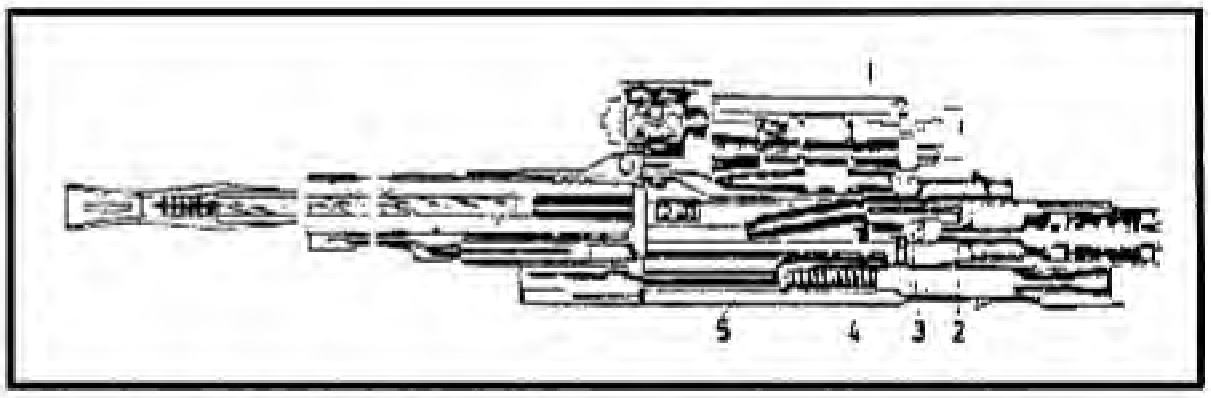
During continuous firing, the processes of cartridge insertion, breech locking, cartridge priming, breech release, and breech recoil with simultaneous ejection of cartridge case tensioning of closing springs will be repeated for as long as the breech catch lever is in its lower position.

In the "continuous firing" position and if a firing break is intended, the release lever is swung into the path of the locking slide. In the "single fire" position, the release lever is swung into the locking slide's path after each round. The recoiling locking slide will press the release lever downwards, the breech catch lever which is subject to spring pressure thus being released from its lower position and jerking upwards. The breech catch lever catches the recuperating breech at the catch edge of the locking slide.

The breech catch impact acting on the trigger mechanism is being elastically absorbed by the latter's buffer. The weapon will remain ready for firing with the breech caught and the closing springs under tension.

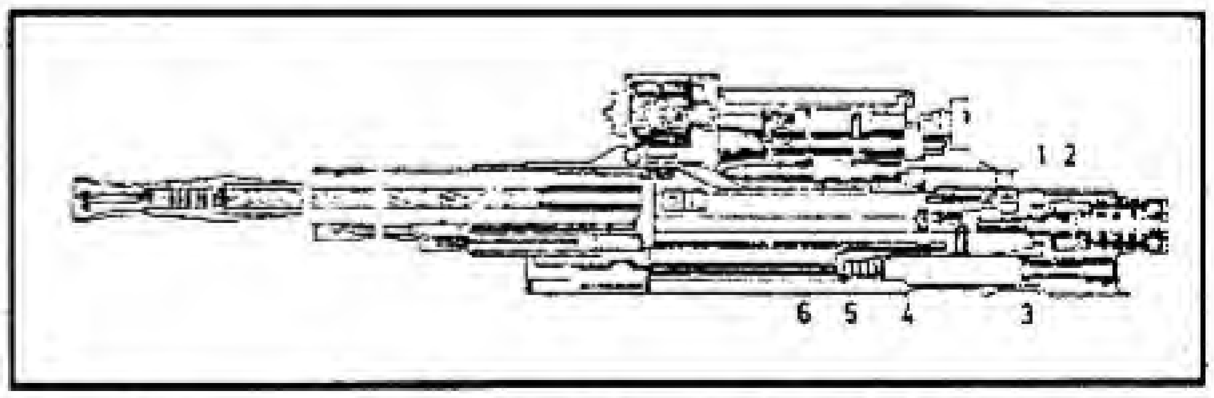
Test Results

The performance of the Mk 20 Rh 202 has been tested on various mounts on the testing ranges of the



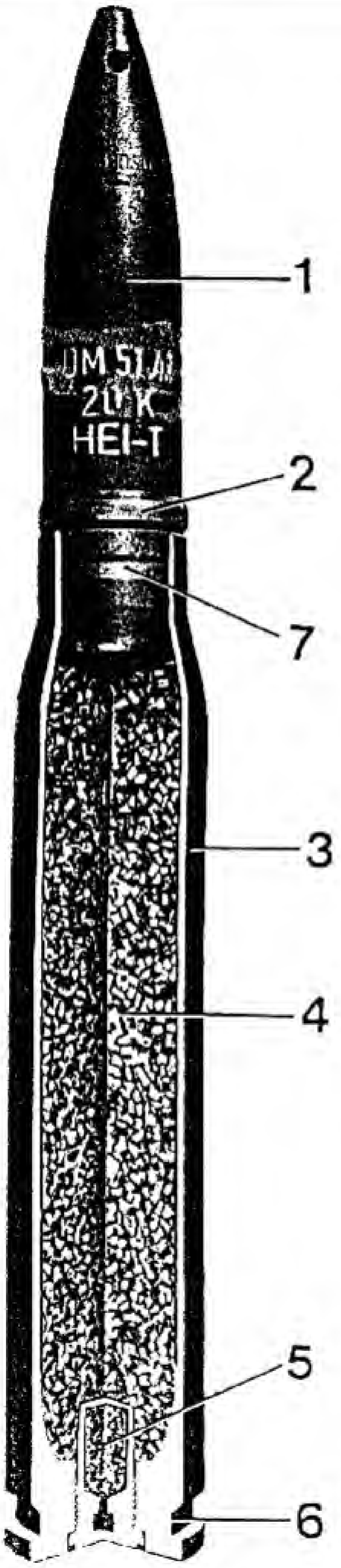
Ejection of the Cartridge Case

1. Ejector
2. Locking Slide
3. Breech Head
4. Extractor
5. Cartridge Case



Final Phase of Breech Recoil (Start of Breech Buffering).

1. Buffer
2. Cup Springs
3. Trigger Buffer
4. Closing Spring
5. Spring Slide
6. Cartridge in Feeding Position (Three-Way Belt Feed)



1. Projectile
2. Rotating Band
3. Cartridge Case
4. Propellant Charge
5. Primer
6. Ejector Groove
7. Crimped Edge of Cartridge

Design of 20mm x 139mm Ammunition

Deutsche Bundeswehr as well as Rheinmetall's own firing range. Under conditions such as temperatures below -54°C (-65°F), lack of lubrication, exposure to splash water and heavy contamination, functional reliability is maintained.

The Aberdeen Proving Ground tests of the Rh 202 confirmed the operational reliability of the gun.

Combat Ammunition

The 20mm x 139mm cartridge is available as: HEI projectile with tracer (DM 51 A 1) and as API projectile with tracer (DM 43).

Fixed ammunition 20mm x 139mm developed and manufactured by Rheinmetall is in use by the Deutsche Bundeswehr.

It is employed in the Mk 20 1 and Mk 20 Rh 202 rapid-firing guns.

Rheinmetall has developed combat and practice ammunition for the various duties of these weapons. The cartridge is identical for the two types of ammunition.

Chapter 31

20mm HS 827-B HURRICANE, 23mm HS 827-C MC-23, 30mm HS 836 SPITFIRE, 30mm HS 837 THUNDERBALL

HISPANO-SUIZA

23mm MC-23

This chapter includes a family of four advanced rapid fire weapon systems, the 20mm HS 827-B Hurricane, the 23mm HS 827-C MC-23, and two 30mm cannons, the HS 836 Spitfire, and the HS 837 Thunderball.

These four cannons were originally developed during 1966 to 1970 by Hispano-Suiza, Geneva, Switzerland. Only these few guns were built before the Hispano-Suiza firm was purchased by Oerlikon in 1971, who acquired all the rights to the guns. The HS 837 Thunderball was the last member of the Hispano recoil-operated, rotating bolt locked guns.

20mm HS 827-B Hurricane

The Hispano 20mm automatic cannon, HS 827-B Hurricane, was designed principally for equipping armoured vehicles of mechanized forces.

The Hurricane 20mm cannon fired the same well known ammunition as the M139 automatic gun.

In comparison with the M139 gun, the HS 827-B Hurricane 20mm differs essentially in the following points:

—smaller in size,
—lighter in weight,
—incorporates selective feeder mechanisms,
—no cradle required for installation since only the gun barrel recoils,
—simplified design principles, thus facilitating manufacturing,
—completely self-contained.

These features together with the rate of fire of the 20mm cannon and the performance of its ammunition render this weapon particularly suitable for mounting either inside or outside armoured turrets or for use from light mountings and helicopters.

Furthermore, the HS 827-B Hurricane 20mm was intended to cover, in parallels with the M139, such a wide range of applications that from the logistic viewpoint its adoption by an army would be entirely rational.

23mm HS 827-C MC-23 Maremont

The MC-23 was designed during 1966 to 1970. The 23mm was designed specifically for the United States Army BUSHMASTER requirement. In 1971, Maremont acquired the rights to the 23mm gun and ammunition and completed a concentrated effort with its Bushmaster team members to finish the development so that operational hardware could be supplied to the United States Army for the Validation Phase.

The MC-23 represented the optimum Bushmaster calibre weapon system in terms of performance, reliability, maintainability, size, weight, volume, and production cost. The gun consists of a low profile, recoil operated gas assisted gun and a family of API, HEIT, MF, and TPT ammunition.

30mm HS 836 Spitfire

The 30mm HS 836 Spitfire is one of the last developments of the Hispano-Suiza firm.

The gun is a rotating bolt locked, short recoil operated gun, designed for light armoured vehicle armament. One feature is a selective dual belt feed. The gun is 108 inches long, 7.9 inches high and 10.2 inches wide. The gun weighs 196 pounds and was designed to fire at a rate of 720 rpm. The 71 inch barrel weighs 95 pounds.

30mm HS 837 Thunderball

This Hispano 30mm cannon was designed principally for equipping armoured vehicles of mechanized forces. The patent applications were filed in1968, and the development of this gun commenced two years later. The Thunderball, a 30mm cannon fires the well known HS 831 ammunition thus offering a far greater increase in fire power and effective range in both antiaircraft and ground fire than any similar weapon system in the United States inventory.

Its advantages are obvious when it is realized that the Thunderball 30mm cannon will:

- —penetrate 32mm of armour at 60 degrees from the verticalaat a range of 1000 meters,
- —that the weight of explosive in the projectile is 50 grams.

Description and Functioning

The following description and functioning pertains to all four cannons in this chapter.

Characteristics
HS 827-B Hurricane

Calibre	20mm
Muzzle Velocity:	
Armour Piercing Ammunition	4134 ft/sec
High Explosive Ammunition	3445 ft/sec
Rate of Fire (selective)	
Muzzle Energy:	
High Explosive Ammunition	59'744 ft. lbs.
Armour Piercing Ammunition	69'292 ft. lbs.
Chamber Pressure	49'782 p.s.i.
Overall Length	99 in.
Overall Height	6.6 in.
Overall Width	7.9 in.
Length of the Gun Body (from the front face at the belt entry to the rear of the gun body)	19.36 in.
Barrel	85 cal.
Total Length of Barrel with Muzzle Brake	76.4 in.
Number of Rifling Grooves	15
Twist of Rifling	6°
Recoil Movement of the Weapon	Zero
Recoil Movement of the Barrel (max.)	1.18 in.
Trunnion Load	1875 lbs.
Total Weight of the Weapon with:	123.4 lbs.
Two Belt Feeders	
Recoil and Run-Out Buffer	
Cocking Mechanism	
Trigger	
Weight of Barrel with Muzzle Brake	52.9 lbs.
Weight of Gun Body	70.5 lbs.
Nose Fan-Radius	5.1 in.
Base Fan-Radius	8.86 in.
Number of Cartridges to Form a Helical Twist of 180°	12

These cannons were designed to be suitable for mounting either inside or outside armoured turrets. The guns incorporate all components necessary for their operation including the recoil and run out buffer, two belt feeders, a cocking mechanism, a hold open mechanism and a trigger. The guns can be stripped and reassembled without tools, and a bayonet lock allows a quick change of the barrel.

On the four cannons only the barrel recoils. The breech is locked by a rotary movement. The firing pin operates only at the end of the locking movement. Unlocking is brought about by using the gas pressure in the barrel.

Characteristics
HS 837 Thunderball

Calibre	30mm
Muzzle Velocity:	
Armour Piercing Ammunition	4363 ft/sec
High Explosive Ammunition	3543 ft/sec
Muzzle Energy:	
High Explosive Ammunition	189'290 ft. lbs.
Armour Piercing Ammunition	191'677 ft. lbs.
Chamber Pressure	51'200 p.s.i.
Overall Length	129.4 in.
Overall Height	7.9 in.
Overall Width	10.2 in.
Length of the Gun Body (from the front face at the belt entry to the rear of the gun body)	25.2 in.
Barrel	75 cal.
Total Length of Barrel with Muzzle Brake	101.4 in.
Number of Rifling Grooves	18
Twist of Rifling	6°
Recoil Movement of the Weapon	Zero
Recoil Movement of the Barrel (max.)	1.97 in.
Trunnion Load	3858 lbs.
Total Weight of the Weapon with: Two Belt Feeders Recoil and Run-Out Buffer Cocking Mechanism Trigger	231.5 lbs.
Weight of Barrel with Muzzle Brake	112.45 lbs.
Weight of Gun Body	119.05 lbs.
Cartridge Belt:	
Nose Fan-Radius	5.27 in.
Base Fan-Radius	11 in.
Number of Cartridges to Form a Helical Twist of 180°	11

These guns can be fired either in automatic or single shot in any position about its axis, through 360°. Two rates of fire are available, selection being made by remote control. The ejection of the fired cases occurs between the two feeders. The ejection of the used links is on either side of the case ejection and in the same direction. Firing starts from the breech-open position.

As the breech bolt moves forward it picks up a cartridge in the feed mechanism, pushes it out of its link and carries it into the chamber. When opening, the breech extracts the fired case from the chamber and it is then ejected. As long as the sear remains withdrawn the guns fire in automatic. Single shot firing is done by the operation of the trigger by the gunner.

The recoiling mass is composed of:
- —The barrel and its muzzle brake,
- —The sleeve, which carries the locking and unlocking mechanism, the feeder control mechanism and the recoil and run-out buffer,
- —The breech block

The barrel is the only external component which moves. A high efficiency muzzle brake limits the recoil force. The gun body is fixed. It requires no cradle and can be secured to the mounting by any simple securing device. The breech block locks into the sleeve which forms an extension of the barrel. The trigger can be operated either by hand, or electrically.

A control device ensure the full engagement of the sear. The cocking mechanism is housed inside the gun body. It can be operated externally either by a hand crank, or remotely by an electric mechanism, etc.

The feeder mechanisms are housed to the right and left of the gun body and lengthwise in the middle. Each feeder mechanism is linked to the other at its rear end by a sliding fork in the upper part of the gun body which fixes the feeder selected in the firing position. The transverse movement of this fork which moves the feeders can be remotely controlled either mechanically or electrically.

The cartridges of the belt for the feeder mechanism engaged for firing are fed into the feed mouth by a system of ratchets mounted on a moving carriage which slides in the feed cover.

The power supply mechanism for the feeder engaged for firing is housed inside the gun body. Thus the cannons represent very high powered and durable weapons of lightweight, easy handling and small size.

30mm Armour Piercing Ammunition - Type SCT

The cartridge has a discarding sabot projectile. Its muzzle velocity of 1330 m/sec (4363 ft/sec) gives a time of flight of 0.8 seconds to a range of 1000 meters.

This ammunition, intended to defeat armoured targets will penetrate an armour plate 32mm (1.26 inch) thick at an inclination of 60° from the vertical at a range of 1000 meters.

The penetrative power of this projectile is roughly three and one-half times that of a normal 20mm A.P. projectile.

Technical Data

Weight of Cartridge	7.40 g	1.63 lbs.
Weight of Projectile	220 g	0.485 lbs.
Weight of Core	150 g	0.331 lbs.
Weight of Sabot	70 g	0.154 lbs.
Weight of Propellant	170 g	0.375 lbs.
Weight of Cartridge Case	350 g	0.772 lbs.
Length of Cartridge	245mm	9.64 in.
Muzzle Velocity	1330 m/sec	4363 ft/sec
Time of Flight for 1000 m		0.8 sec.
Chamber Pressure	3600 kg/cm²	51'200 p.s.i.
Armour Penetration at 1000 m inclined at 60°	32mm	1.26 in.
Armour Penetration at 1500 m inclined at 60°	25mm	0.98 in.

20 x 139 HS 820 developed from Swiss 20mm Flab. Kan 38 (Photo courtesy of Woodin Laboratories)

30mm High Explosive Ammunition - Type HEIT

The muzzle velocity of this ammunition is 1080 m/sec (3543 ft/sec) and the time of flight for a range of 1500 meters is on the order of 1.78 seconds.

The projectile of a weight of 360 grams contains 50 grams of high explosive which is approximately five times the quantity contained in an ordinary 20mm high explosive projectile.

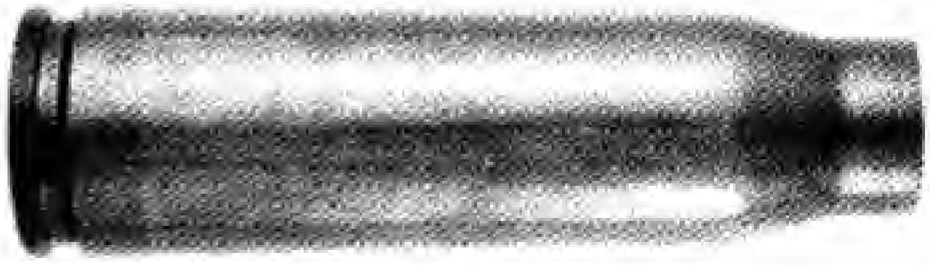
This ammunition has a shuttered fuze, thus the detonation train is not broken until after leaving the barrel when the shutter brings the detonator into line with the striker, so giving complete safety in storage and in the bore.

The excellent ballistic performance together with the splinter and incendiary effect of this ammunition make it suitable for engaging both ground and aerial targets.

23mm HS 728-C used in Maremont/Hercules and Smith & Wesson Weapons. (Photo courtesy of Woodin Laboratories)

Technical Data

Weight of Cartridge	870 g	1.92 lbs.
Weight of Projectile	360 g	0.794 lbs.
Weight of High		0.11 lbs.
Explosive Filling	50 g	0.353 lbs.
Weight of Propellant	160 g	0.772 lbs.
Weight of Cartridge Case	350 g	11.24 in.
Length of Cartridge	285.5mm	3543 ft/sec
Muzzle Velocity	1080 m/sec	51'200 p.s.i.
Time of Flight for 1500 m		1.78 sec.
Chamber Pressure	3600 kg/cm²	
Time to Self-Destruction (min.)		7 sec.

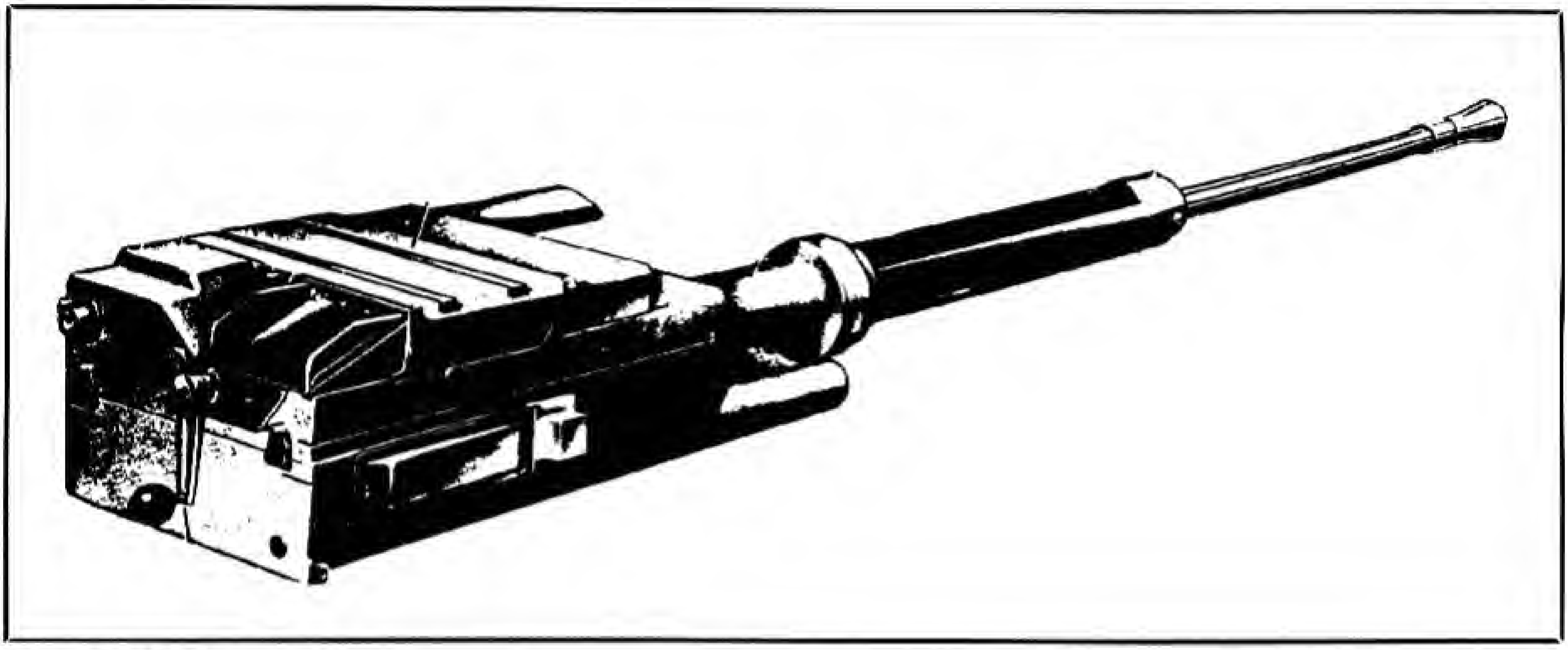

30mm HS 836 Projectile (Photo courtesy of Woodin Laboratories)

Chapter 32

30mm X21E2 AUTOMATIC GUN

RARDEN UNITED KINGDOM

(Royal Armament Research and Development Establishment)



30mm X21E2 Automatic Gun

History

In the late 1960's, Royal Armament Research and Development Establishment, Fort Halsted and the Royal Small Arms Factory in Enfield began jointly developing a new 20mm gun for use in the 1970's. Research showed that guns of 20mm and 25mm would have insufficient punch to be effective in the 1970's, and the requirement for the new gun, therefore, demanded first the defeat of light armour at ranges up to at least 1,000 meters, and secondly, infantry support and a limited capability against low-flying aircraft. It was designed to attack with individually-aimed single shots which require a much lighter mounting than most automatic weapons.

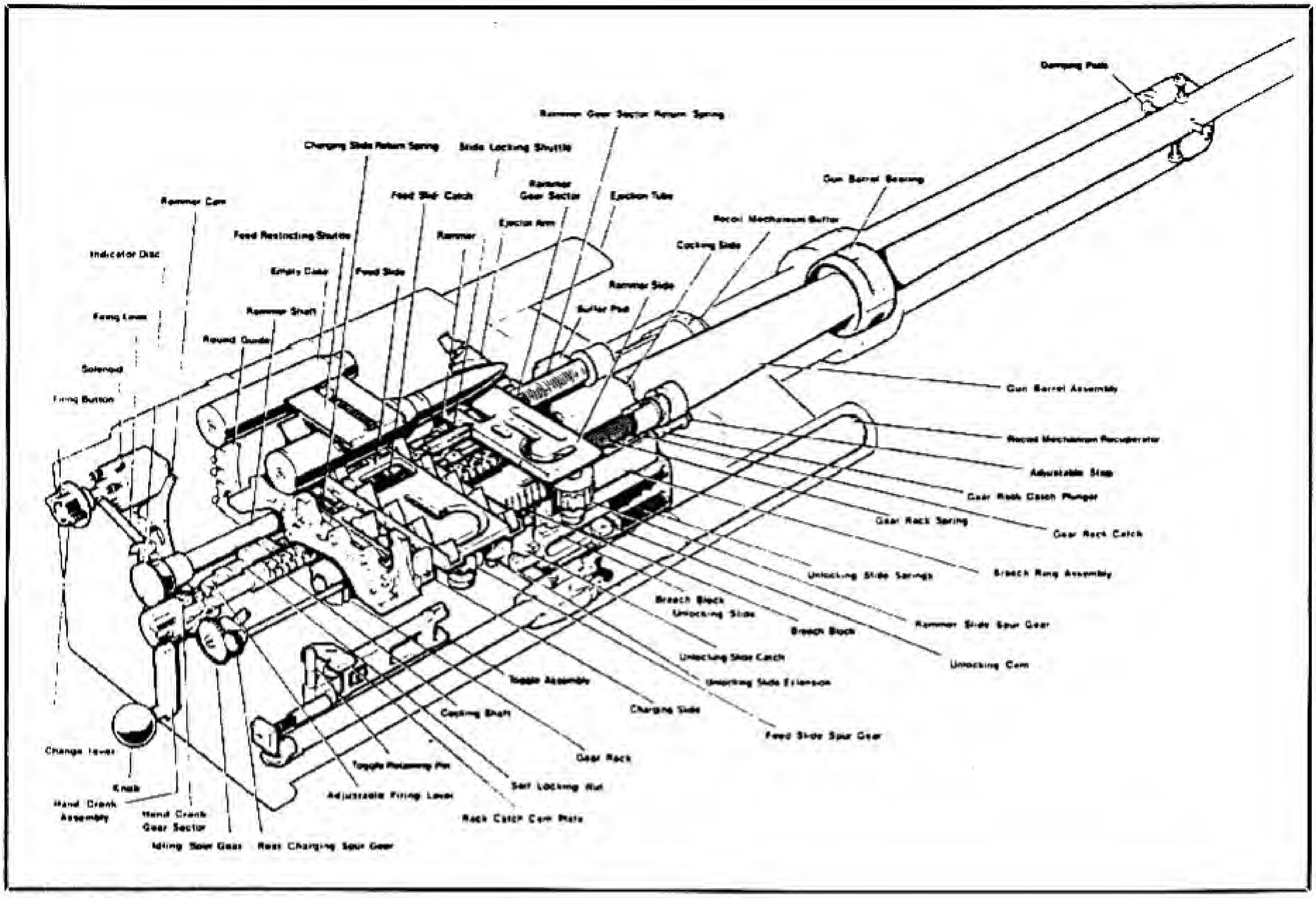
Description and Purpose

The Rarden 30mm is designed to arm light armored vehicles and give them the capability of defeating other light to medium armored vehicles. It is primarily used as a semi-automatic weapon.

The ammunition used is the Oerlikon manufactured HS831L 30mm round (1080 m/sec) and a special RARDE Armour Piercing Discarding Sabot round (1200 plus m/sec).

The overall length of the gun is 117 inches (only 9 inches must be inboard) and the weight is about 210 pounds. The quick-change barrel, 96 inches long, weighs 59 pounds with flashhider. The gun is capable of automatic fire at 120 rounds per minute for a maximum of six rounds (those six are one in the chamber and five in the feedway). The gun is fed with three round clips.

The method of operation is long recoil and locking is with a sliding breech block.


Damping Pads
Rammer Gear Sector Return Spring
Charging Slide Return Spring
Slide Locking Shuttle
Rammer Gear Sector
Gun Barrel Bearing
Rammer Cam
Feed Slide Catch
Ejection Tube
Recoil Mechanism Buffer
Feed Restricting Shuttle
Ejection Arm
Indicator Disc
Rammer
Cocking Slide
Empty Case
Feed Slide
Rammer Slide
Firing Lever
Rammer Shaft
Buffer Pad
Round Guide
Solenoid
Firing Button
Gun Barrel Assembly
Recoil Mechanism Recuperator
Adjustable Stop
Gear Rack Catch Plunger
Gear Rack Spring
Gear Rack Catch
Unlocking Slide Springs
Breech Ring Assembly
Breech Block Unlocking Slide
Breech Block
Rammer Slide Spur Gear
Unlocking Slide Catch
Unlocking Cam
Toggle Assembly
Unlocking Slide Extension
Charging Slide
Cocking Shaft
Feed Slide Spur Gear
Change lever
Gear Rack
Toggle Retaining Pin
Knob
Self Locking Nut
Adjustable Firing Lever
Hand Crank Assembly
Hand Crank Gear Sector
Rack Catch Cam Plate
Idling Spur Gear
Rear Charging Spur Gear

30mm RARDEN Cannon

Cycle of Operation

Hand cocking, by rotating a small handle, is required only at the start of action. The breech is held open on firing the last round and closed by pressing a catch after reloading the magazine.

The gun operates on the long recoil system. When the gun fires, the breech ring, breech block, rammer, barrel, buffer cylinder and recuperator cylinder all move 13 inches inside the non-recoiling casing, against the buffer, compressing the air in the recuperator.

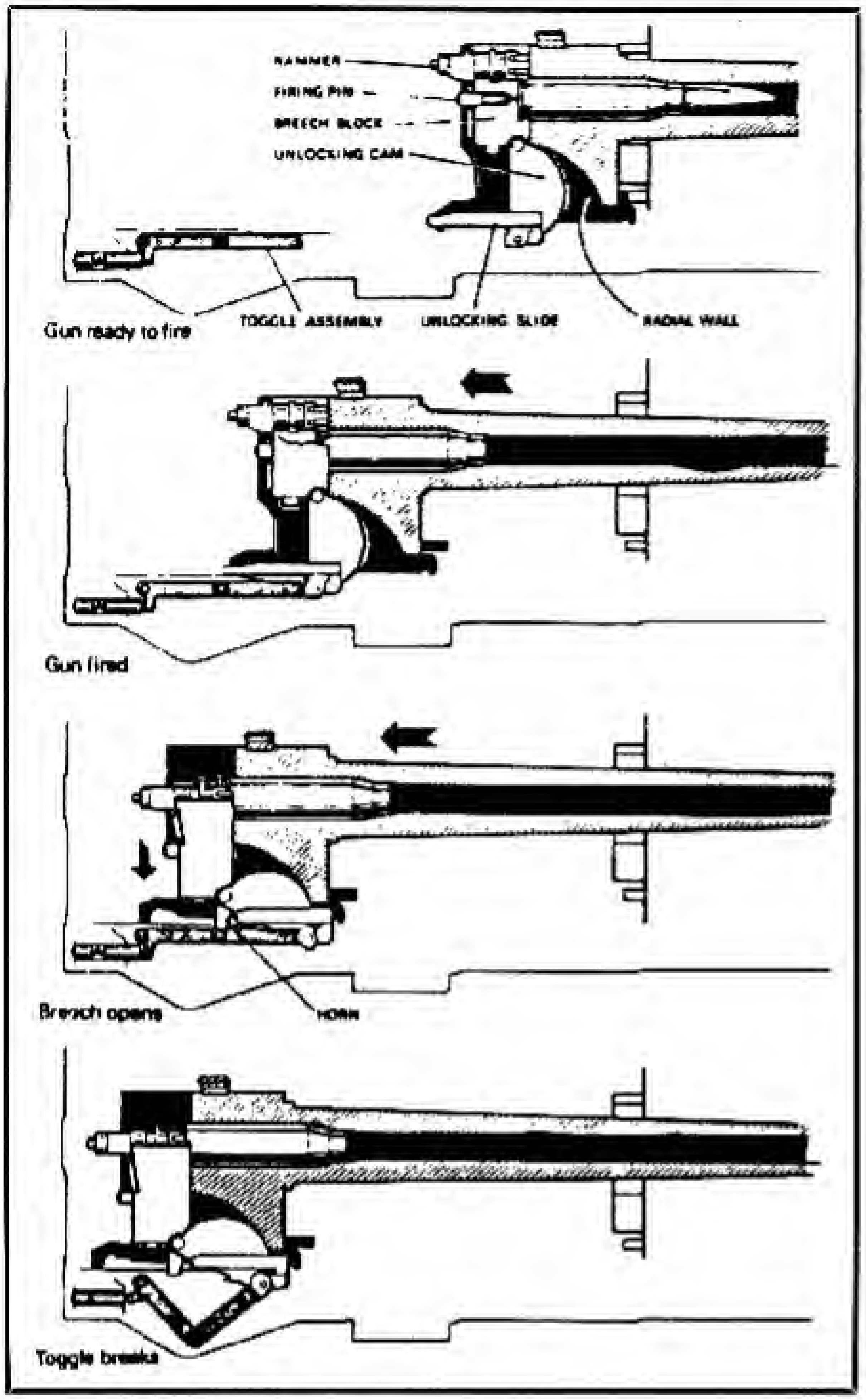
The breech block remains locked for the first 9 inches of recoil and is then opened by a cam attached to the block which rolls round a radial wall of twice its own diameter in the breech ring. This produces a movement of the breech block at right angles to the barrel axis and at the same time the rammer is drawn down to grip the empty case.

When the recuperator drives the barrel and ring forward, the empty case is left on the rammer at the rear. The breech block is held open. After 8 inches of run out the rammer is rotated to line up with the feed slide, which then moves across from right to left, pushing the empty case into the ejector way and a live round into the rammer claw.

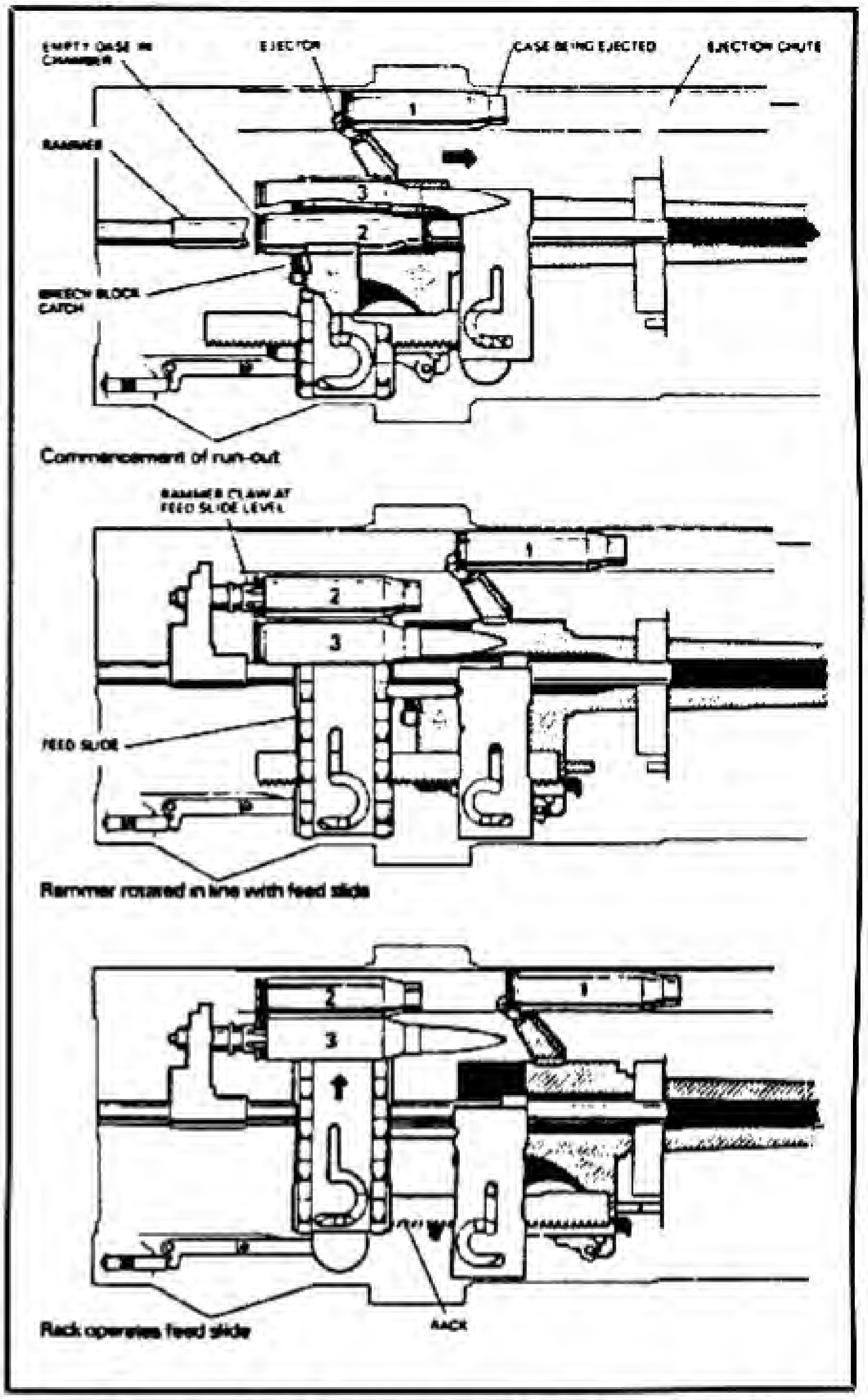
The final forward movement of the breech ring

Characteristics

Weight	210 lb. approx.
Length	116.5 in.
Calibre	30mm
Weight of Barrel	54 lb. approx.
Weight of Barrel, with Flash Hider	59 lb. approx.
Length of Barrel	96 in.
Rifling:	
Number of Grooves	18
Twist of Grooves	6° RH constant pitch
Depth of Grooves	0.6mm
Width of Lands	3mm


RAMMER
FIRING PIN
BREECH BLOCK
UNLOCKING CAM
Gun ready to fire
TOGGLE ASSEMBLY
UNLOCKING SLIDE
RADIAL WALL
Gun fired
Breech opens
HORN
Toggle breaks

Cycle of Operation


EMPTY CASE IN CHAMBER
EJECTOR
CASE BEING EJECTED
EJECTION CHUTE
RAMMER
1
3
2
BREECH BLOCK CATCH
Commencement of run-out
RAMMER CLAW AT FEED SLIDE LEVEL
1
2
3
FEED SLIDE
Rammer rotated in line with feed slide
2
1
3
Rack operates feed slide
RACK

Runout Sequence and Positioning of Next Round for Firing

ejects the empty case from the previous round forward out of the gun. The rammer is rotated to carry the live round down into line with the bore and then moved forward to feed the round into the chamber. The rammer releases the sliding block which pushes it into a recess in the breech ring. The gun is now ready to fire and the firing hammer is released from the sear by the gunner operating either the firing button or a solenoid.

Mechanical safety before firing is controlled by the breech block which pushes out a safety plunger when it is fully home. This releases the safety sear and leaves the hammer held by the sear. After firing, the free recoil of 9 inches ensures that the pressure is down to atmospheric before the breech opens.

The feed mechanism is designed to take two three round clips. The clip releases the rounds as soon as they are pushed in from the rear.

Gun Body and Barrel

For lightness the gun body is of cast aluminum alloy in two parts. The bottom casing contains the recoiling masses and the top case houses the feed, firing and cocking mechanisms.

The barrel is of monobloc construction in high yield steel, threaded at the breech end for attachment to the breech ring and at the muzzle for a flash hider. A barrel catch engages serrations at the breech end to prevent barrel rotation.

The use of high quality steel has produced a very light barrel of only 54 lb. with a length of 96 in. Like all light, long barrels the paramount problem in obtaining both accuracy and consistency is to control the vibration pattern on loading and firing. This is

Ammunition Data - 30mm Rarden Gun

	RARDE		Hispano-Suiza	
	APDS*	High Explosive UIAT	Armour Piercing RINT	Practice ET
Weight of Projectile (g)	290	360	360	360
Weight of HE Filling (g)	—	28	—	—
Weight of Cartridge Case (g)	350	350	350	350
Weight of Complete Round (g)	870	870	870	870
Weight of 3-Round Clip (lb.)		6	6	6
Length of Complete Round (in.)		11.25	11.25	11.25
Muzzle Velocity (m/sec)	1200+	1180	1100	1080

*Figures for APDS are approximate.

Range Table (ground to ground) for Hispano-Suiza Rounds

Range (m)	Elevation (mils)	Time of Flight (sec)	Residual Velocity (m/sec)
400	2.0	.39	976
1000	5.5	1.08	820
2000	13.7	2.59	585
3000	27.4	4.70	394
4000	51.4	7.71	300

Maximum range with self-destruction is 3,800-4,700 m, and without, 10,200 m.

done in the Rarden by having a front bearing situated about one-quarter of the barrel length from the breech, and sliding in the barrel sleeve. The vibrations are damped by four damping pads at the end of the barrel sleeve. These are given a clearance of .003 in. between pad and barrel.

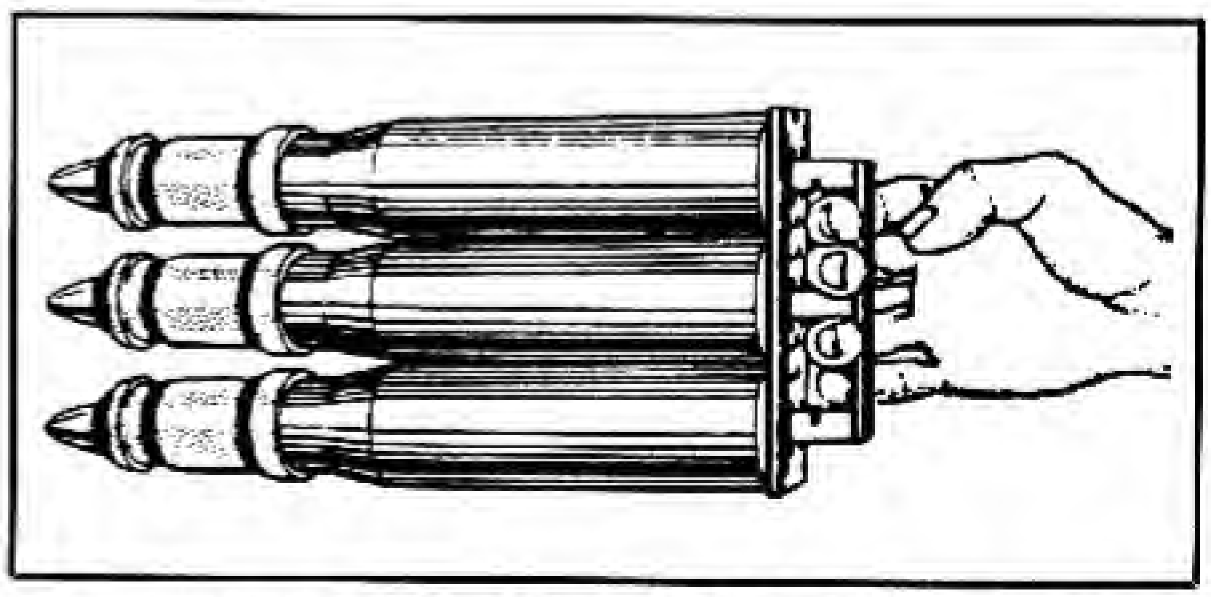
Changing the barrel is a simple operation. The flash hider is screwed off, the barrel catch lifted and the barrel screwed out. The breech end is then pushed forward, lifted and then pulled back. The barrel will normally be removed during long non-operational moves and stowed on the hull of the vehicle.

Ammunition

The first decision required was whether to adopt an existing round or to produce a completely new one; and it was decided that a new APDS round would be needed for the primary role of armour attack. The Royal Armament Research and Development Establishment, which produced the very successful APDS rounds for the 20 pounder, the 105mm and the 120mm tank guns, accepted this task.

For the remaining roles, it was decided to use the Hispano-Suiza 831L ammunition, which is well-proven and the high explosive content (three times that of a 20mm shell) which makes it particularly valuable against soft targets on the ground and in the air.

When the 30mm APDS round was developed, it was found that, if fired at the sides of some current light AFVs and APCs, as opposed to their frontal armour, the round will pass literally clean through the vehicle without stopping, inflicting only minimal damage on everything out of its immediate path. It was therefore decided to develop a further type of round, known as AP(SE) - Armour Piercing (Special Effects) - which will pierce one side of an APC or light AFV and then burst in the interior, causing maximum damage to personnel and equipment. The AP(SE) round is a British design based on the Hispano-Suiza RIA round with high explosive filling, and is an improvement on the HS831L ammunition.

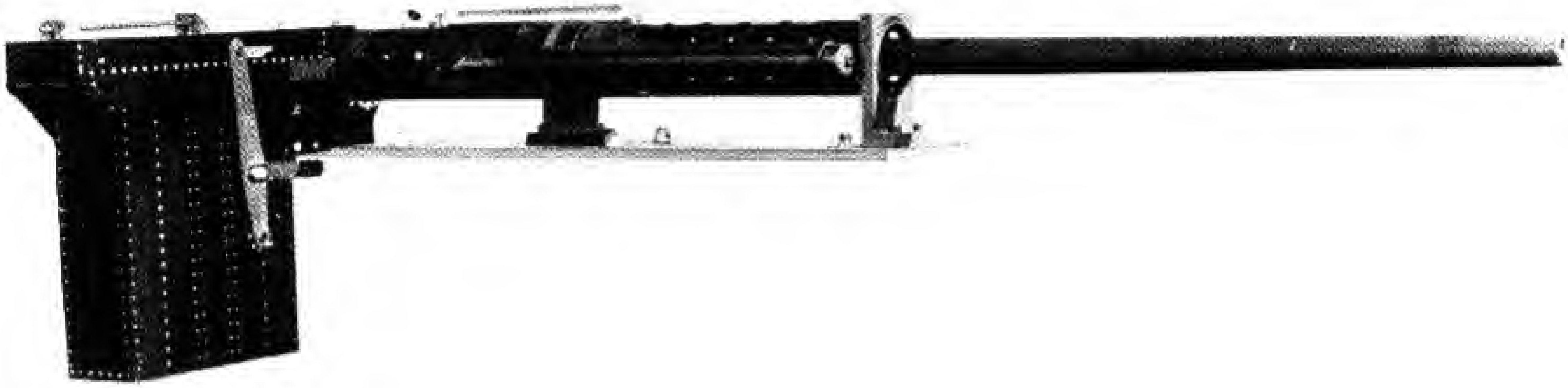


Ammunition is held in Clips of Three. When Rounds are Pushed in, Clip becomes Detached.

Chapter 33

30mm LOCKLESS AUTOMATIC GUN SYSTEM

HUGHES TOOL COMPANY (Presently McDonnell Douglas)



30mm Lockless Automatic Gun

History

The 30mm lockless gun, together with its ammunition was sponsored by the U.S. Army Armament Command for potential use on attack helicopters in the 1980's and beyond. The program has been conducted in phases which were intended to culminate in an optimized system ready for engineering development.

Although effort during Phase I of the program was concentrated on ammunition development, sufficient data was obtained from a gun and recoil system test fixture to provide baseline data for the design of a first generation automatic gun and feed system.

Description

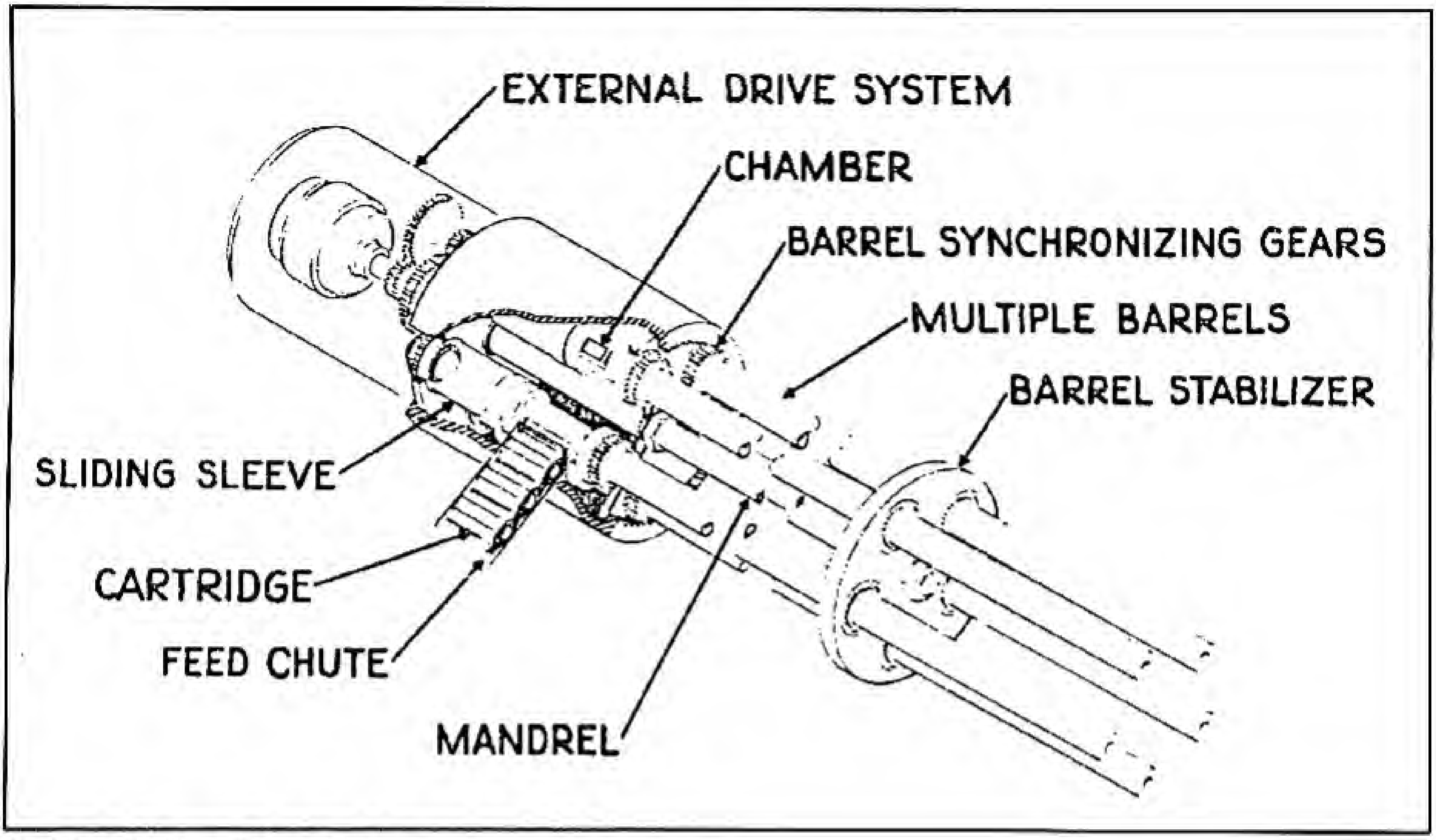
The 30mm lockless automatic gun fixture is a recoil operated, pneumatically fed weapon utilizing a fire-out-of-battery system to reduce trunnion reactions. It was configured to fire Mod 1 cartridges, but is easily convertible to fire the shorter, higher impulse Mod 2 cartridges.

A total of 389 Mod 1 cartridges have been fired from this fixture, including three 30 round, one 26 round, and one 17 round burst. Rate-of-fire varied between 200 and 230 rounds per minute. This fixture employs the basic lockless chamber and obturating sleeve configuration with several design improvements. The barrel return springs are outside the barrel jacket where they will be less affected by barrel heat, and the sleeve latch is at the front end of the sleeve, so that it will not ride over the ring seals during operation.

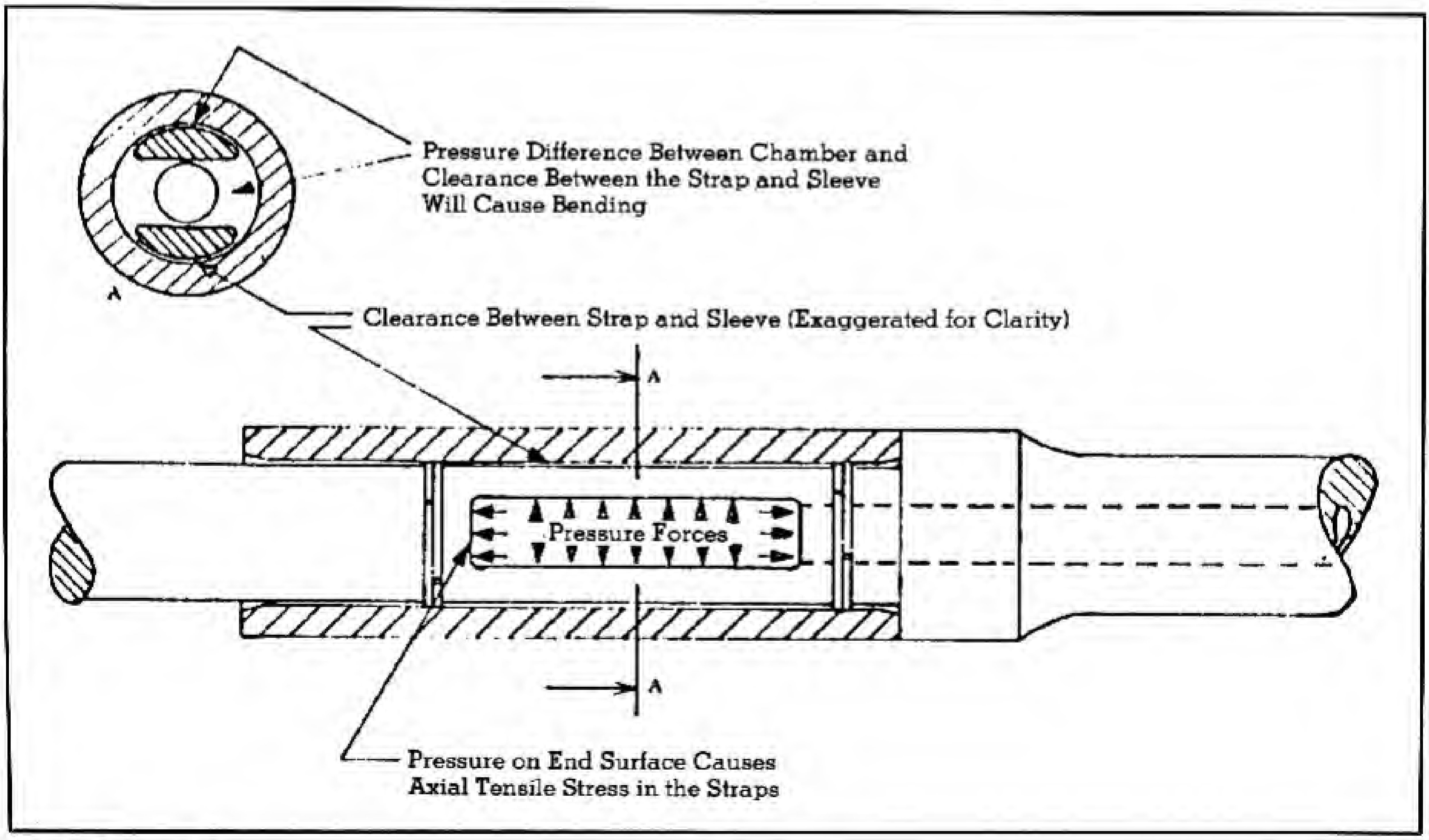
Another improvement is that this fixture uses a magazine which holds 50 rounds in five columns of 10 rounds each. The columns are spring loaded and feed by a pawl-and-shuttle mechanism located at the top of the feeder. The design of this automatic test fixture originally included a feed system which was operated by a pneumatic cylinder that drove the feed pawls through a coupled linkage. In order to achieve greater simplicity and increased reliability, this design was modified to accept a pneumatic cylinder mounted directly on the magazine.

Cycle of Operation

The design of this fixture was influenced by the fact that the rectangular shaped flat round is fed into the chamber laterally rather than axially. The feed


EXTERNAL DRIVE SYSTEM
CHAMBER
BARREL SYNCHRONIZING GEARS
MULTIPLE BARRELS
BARREL STABILIZER
SLIDING SLEEVE
CARTRIDGE
FEED CHUTE
MANDREL

High Rate Lockless Weapon System


Pressure Difference Between Chamber and Clearance Between the Strap and Sleeve Will Cause Bending
A
Clearance Between Strap and Sleeve (Exaggerated for Clarity)
A
Pressure Forces
A
Pressure on End Surface Causes Axial Tensile Stress in the Straps

Forces During Firing

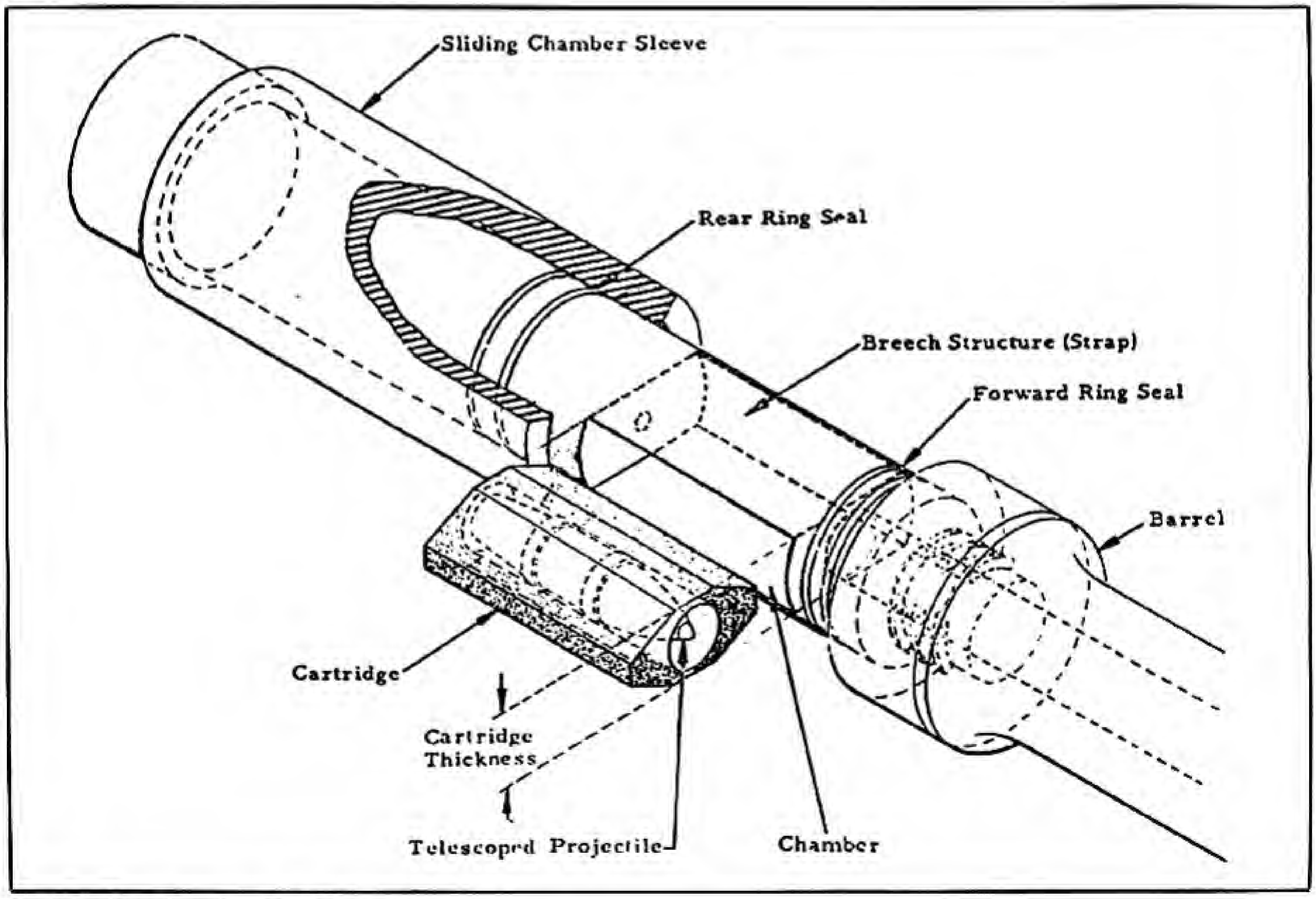
Characteristics

Calibre	30mm
Ammunition	Hughes Lockless
Cartridge Case Material	Plastic
Projectile Weight	5500 grains
Muzzle Velocity	3500 fps
Length	110 in.
Width	11.75 in.
Height	11 in.
Weight	250 lb.
Method of Operation	Long recoil
Feed	Pneumatic
Rate of Fire	350 spm
Trunnion Loads	2200-2600 lb.
Recoil Reduction Method	Pre-battery firing
Recoil Adapters	Internal

tray was designed to lock to the moving chamber during the feed cycle. This action allows the chamber to be aligned with the cartridge to be fed and the subsequent feeding action to be accomplished during the recoil cycle.

At the beginning of the cycle, the feed control valve is actuated and pneumatically powered feed pawls start to push the round into the chamber. A round stop/ejector flips up before the new round is completely chambered and discards the expended round while preparing to stop and center the new round in the chamber. At the same time, the feed pawl slide unsears the chamber which moves forward to be fired. The process repeats until the trigger is released.

The Hughes Lockless program included a variety of calibres, including 5.56mm, Calibre .50, 27mm, and 40mm.

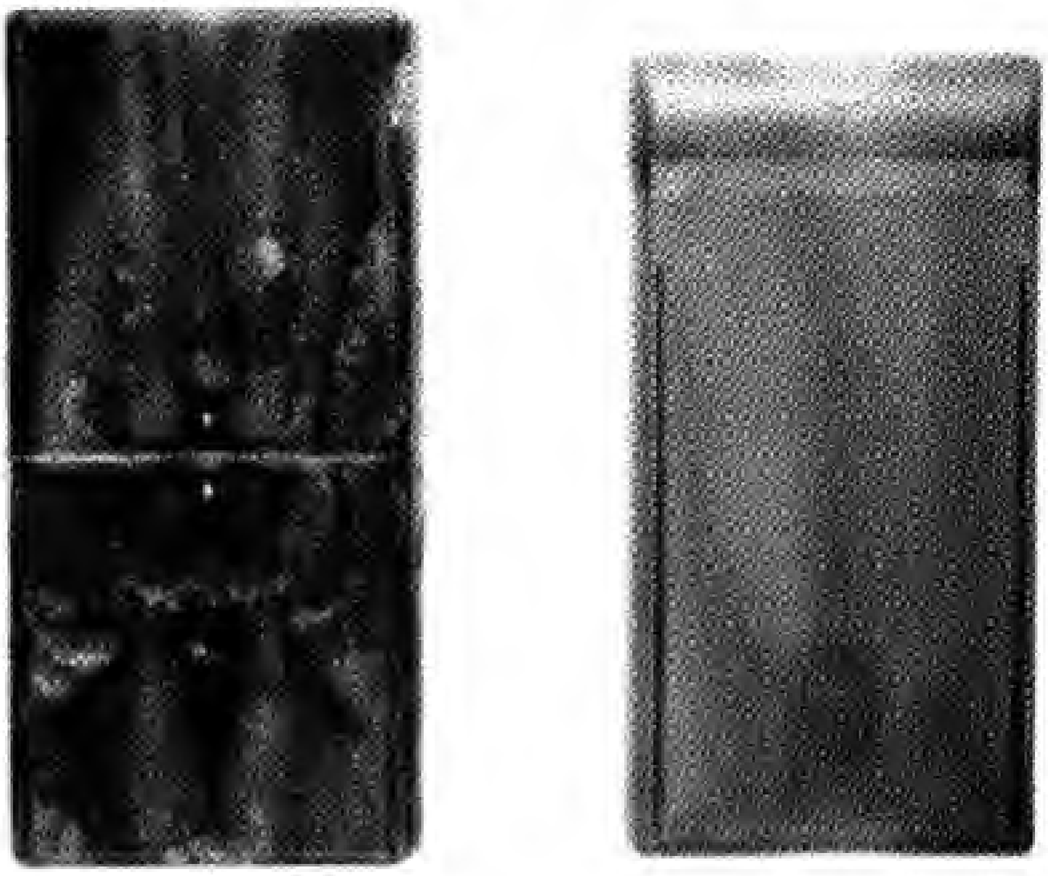

Sliding Chamber Sleeve
Rear Ring Seal
Breech Structure (Strap)
Forward Ring Seal
Barrel
Cartridge
Cartridge Thickness
Telescoped Projectile
Chamber

Basic Lockless Caseless Gun Concept

Ammunition

During the early stages of the program, all ammunition development was concentrated on the Mod 1 cartridge which used WC 870 powder to propel a 5000-grain projectile. The development of this cartridge culminated in the Mod 2 version.

Recent ammunition development focused on the new Mod 2 cartridge which employed consolidated propellant to fire a ten percent heavier (5000 grain) projectile at the same muzzle velocity as the Mod 1. Most of the full-scale development of powder forms was conducted at Brunswick Corporation's Sugar Grove, Virginia facility where a 203-shot program concentrated on propellant, ignition, and cartridge case refinement. The test series culminated in a 70-shot lot acceptance series which demonstrated a satisfactory combination of muzzle velocity, chamber pressure, and action time at both elevated and reduced temperatures.

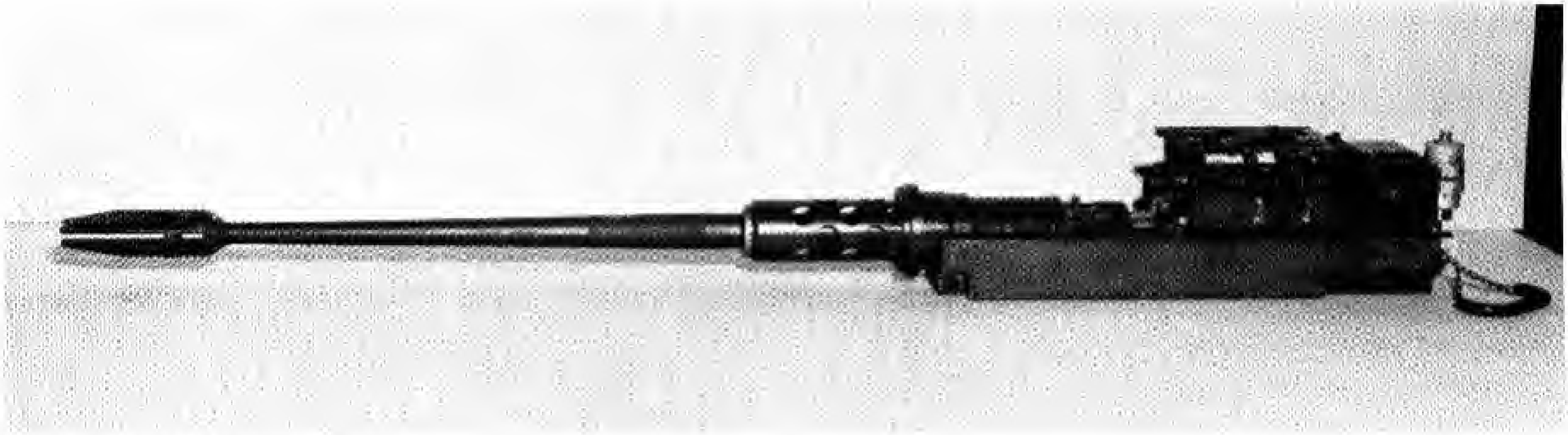


Hughes Lockless 30mm Ammunition. Left - early type. Right -later type. (Photo courtesy of Woodin Laboratories.)

Chapter 34

20mm EX-29, Mk 29 and GE-120B MACHINE GUN

GENERAL ELECTRIC



20mm GE-120B Machine Gun

History

Work began on the GE-120 in January 1968 primarily in response to the Navy requirement for an improved single barrel gun to fire the M50 series of 20mm ammunition. The GE-120A was developed to fire the M50 series ammunition as well as the Hispano-Suiza HS820 ammunition. That version which fired the HS820 ammunition was designated the GE-120H, but it essentially was a GE-120A gun with a special feeder to handle the HS820 round. The GE-120A gun was first test fired in July 1968.

In June of 1969 the development of the GE-120B was initiated. This model fired only the M50 series ammunition and incorporated other improvements over the GE-120A. The GE-120B extensively tested by NWL, Dahlgren, as reviewed in the Test Results section. The gun was type classified the EX-29 Mod 0 in February 1972 and later, the Mk 29 Mod 0. The weapon was adopted by the United States Marine Corps for their LVTP-2 assault amphibian personnel carrier.

The Mk 29 has served as the basis for the GE-127A gun.

Description and Purpose

The Mk 29 is a single-barrel, recoil-operated gun capable of firing at any rate from single shot to 550 shots-per-minute. The gun was designed to achieve a broad applicability. The short receiver (11.30-inch centerline of feeder to rear of solenoid) adapts for turret, or pintle installations. The gun fires unlubricated ammunition with low gas contamination.

Both a single feeder and a dual feeder were developed for the Mk 29. A Mk 29 equipped with a dual feeder was designated the GE-120C gun. A description of the operation of the dual feeder is presented in the section on the GE-127A gun. The dual feeder on the GE-120C is a scaled down version of the dual feeder on the GE-127A.

Cycle of Operation

The operating or firing cycle is initiated from the open bolt position to avoid the cook-off danger of closed bolt designs where a live round must be in the chamber before the trigger is depressed.

The cycle of operation is initiated by retracting the bolt to the open position, where it is held by the

Characteristics

GUN:	Single Feeder	Dual Feeder
Length	76 in.	74.5 in.
Width	6.5 in.	9.25 in.
Height	8.6 in.	8.6 in.
Weight	126 lbs.	130 lbs.
No. of Barrels	1	
Gun Life	50,000 rds	
Bore	20mm	
Barrel		
Length	48 in.	
Weight	30 lbs.	
Ammunition	M-50 series and Mk 147, EX-157 - 163 (percussion primed)	
Method of Operation	Short recoil, modified Browning cycle	
Feeder	Sprocket type, uses linked belted ammo - M14 link	
Rate of Fire:		
Electrically pulsed	Variable to 550 spm	
Mechanical rate reducer	250 or 550 spm	
Muzzle Velocity	3300 fps	
Recoil Force (on rigid stand)	Peak 7200 lbs. RMS 3800 lbs.	
Power Required:		
Firing Solenoid	28 vdc - 20 amps	
Electric Primed Ammunition	300 vdc - 0.5 amps	

sear, compressing the bolt and barrel extension return springs. The barrel and barrel extension are held out of firing position by the interaction of the accelerator between the barrel extension and the bolt assembly. The movements of the gun may best be described under counterrecoil and recoil movements while the operations would be intermediate or full automatic firing.

Counterrecoil Movement. After the sear release, the return spring moves the bolt forward, and the rammer at the upper front of the bolt face contacts the base of a round in the feed tray. The rammer then forces the round forward into the cartridge ramp where it is guided downward into the barrel and at the same time into engagement with the extractor. As it moves forward, the bolt engages the accelerator, releasing it to pivot and start its return in the cam path, allowing the barrel extension return springs to move the barrel and barrel extension forward. Bolt velocity decreases while in contact with the accelerator, and the barrel and barrel extension gain velocity from the bolt through the accelerator. About 0.75 inch from firing position, the accelerator, bolt, and barrel extension reach the same velocity and continue forward together. The striker of the firing mechanism is engaged by the bolt at this point, and the chambering action is completed.

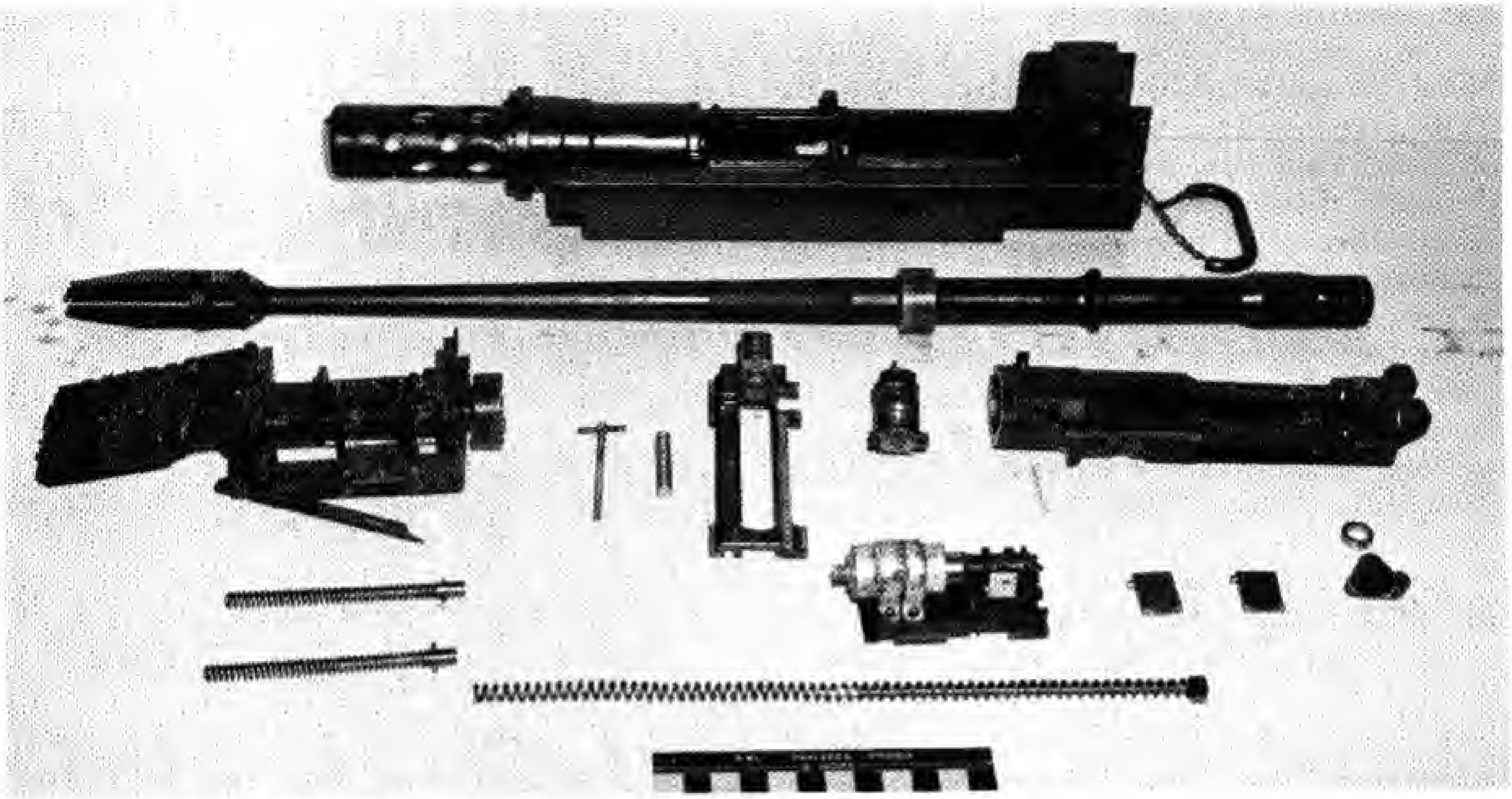
As the barrel extension moves forward under the feeder assembly, the right and left-hand bolt locks in the barrel extension are moved inward behind the bolt by cams in the bottom of the feeder. The bolt and barrel extension continue their forward movement.

Single or Dual Feeder. Using a single feeder, the gun can be fed from either the right or left side. The dual feeder allows easy selection of either API or HEI ammunition for more effective target defeat.

The feeder drive assembly is connected to the rear of the bolt extension by the rotator drive pin. The forward movement of the barrel and barrel extension causes the feeder drive to rotate. The feeder drive pawl, in engagement with the inner ratchet face of the feeder drive wheel, moves downward to rotate the feed wheel 45°. This motion advances the ammunition belt one-half a link pitch.

The striker of the firing mechanism, engaged by the bolt at the start of bolt locking, is carried forward compressing the striker spring. Just before firing position, the sear on the bolt is cammed off the striker, releasing the striker. Spring action then drives the striker rearward to strike the hammer in the bolt assembly. The hammer pivots, striking the firing pin and drives it forward to fire the round. Final forward motion of the bolt, barrel and barrel extension is checked by the initial part of the rearward thrust exerted by the exploding propellant charge and the counterrecoil buffer.

Recoil Movement. The combined energy generated by the fired round and the counterrecoil buffer spring drives the barrel, barrel extension, and locked bolt into their recoil stroke as one mass while holding the cartridge case firmly chambered during the first inch of recoil travel. This allows enough time for the projectile to leave the muzzle and the residual pressure to decrease to a safe limit. During the next inch of travel the bolt locks are cammed free of the bolt and bolt acceleration is initiated with the bolt and barrel extension still interlocked. As the accelerator cam pivots, the accelerator acts against the bolt and accelerates it rearward, extracting the spent case from the chamber. At the end of bolt acceleration the



Disassembled 20mm GE-120B Machine Gun

motion of the accelerator is restricted and the barrel and barrel extension are brought to rest and then reversed in motion by the barrel buffer spring. Forward motion of the barrel and barrel extension is arrested by the accelerator cam which is buffered to absorb the shock load.

As the barrel extension moves rearward, the feeder is actuated and the ammunition belt is incremented another one-half a link pitch to position a round in the feed tray. The bolt and spent case continue to the rear. As the bolt passes under the round in the feed tray, spring-loaded ejectors, mounted in the barrel extension, project into the path of the spent case pivoting it out of the extractor and spinning it downward out of the receiver. The bolt continues rearward movement and impacts the bolt buffer which absorbs the remaining recoil force and starts the counterrecoil movement.

Mk 29 Mounted on a Tank

Single Shot, Intermediate, and Full Automatic Firing. In single shot firing the bolt will sear up after one shot is fired. The solenoid must be deenergized momentarily before another shot can be fired. If intermediate rate of firing has been selected, the recoiling bolt contacts the forward housing assembly which causes the rate control assembly to override the energized solenoid and causes the sear to move into position to engage the bolt. The sear hook on the bolt passes over the sear and the sear snaps up to the rear. After striking the buffer, the rebounding bolt engages the sear and is held for a short interval before the sear is released by action of the rate control assembly. If automatic firing has been selected, the sear is held out of the path of the recoiling bolt by the energized solenoid, the cycle is repeated and the gun will continue to fire automatically until the solenoid is released or the ammunition supply has been depleted.

Test Results

During the period March through October 1971, Naval Weapons Laboratory, Dahlgren, Virginia (NWL) conducted a comparative evaluation of four improved 20mm surface weapons for NAVORD to determine if any of the weapons were suitable for Navy surface use. The purpose of the evaluation was to provide a basis for selection of a candidate 20mm weapon suitable for pintle or turret mounting, capable of operating on the open bolt principle to preclude cookoff, and capable of being loaded and fired by one man. It should field strip quickly and easily without the use of tools. It should have a quick change barrel and be capable of at least two rates of fire, with a 600 spm maximum.

As a result of that evaluation, two weapons were selected for further consideration; the General Electric 20mm Mk 29 Mod O machine gun was one of those selected.

Accordingly, in May and June 1972, NWL began evaluation of two of the GE guns using new steel case percussion primed rounds.

During safety certification, frequent parts breakage was experienced.

At the beginning of the certification, a steel striker rod was installed in each of these weapons, replacing an aluminum rod used during the previous evaluation at NWL. During the certification, it was discovered that the steel striker rod weighed almost twice as much as the aluminum rod it had replaced. That weight difference changed loads in the firing mechanism and could have contributed to some of the firing mechanism failures. Two attempts were made to fire a 400 round burst; neither attempt was successful.

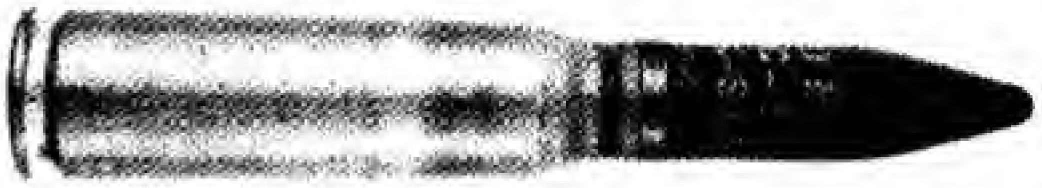
A total of 8,919 rounds was fired from the two test guns used in the certification; MRBS (mean rounds between stoppages) was 743 rounds for the two guns combined.

All stoppages experienced during firing were cleared quickly and safely. No unsafe situation occurred during any of the firing. This weapon can be loaded, fired, cleared, and unloaded in complete safety by personnel familiar with the weapon, if recommended procedures are followed.

Based on the evaluation, it was recommended that the GE-120B be adopted for service use pending correction of minor deficiencies.

Ammunition

Electric or Percussion Primed Ammunition. A pulse solenoid or a mechanical rate reducer is used to reduce the rate of fire when using either electric or percussion primed ammunition. The gun can be easily reconfigured in the field to fire either type of ammunition.

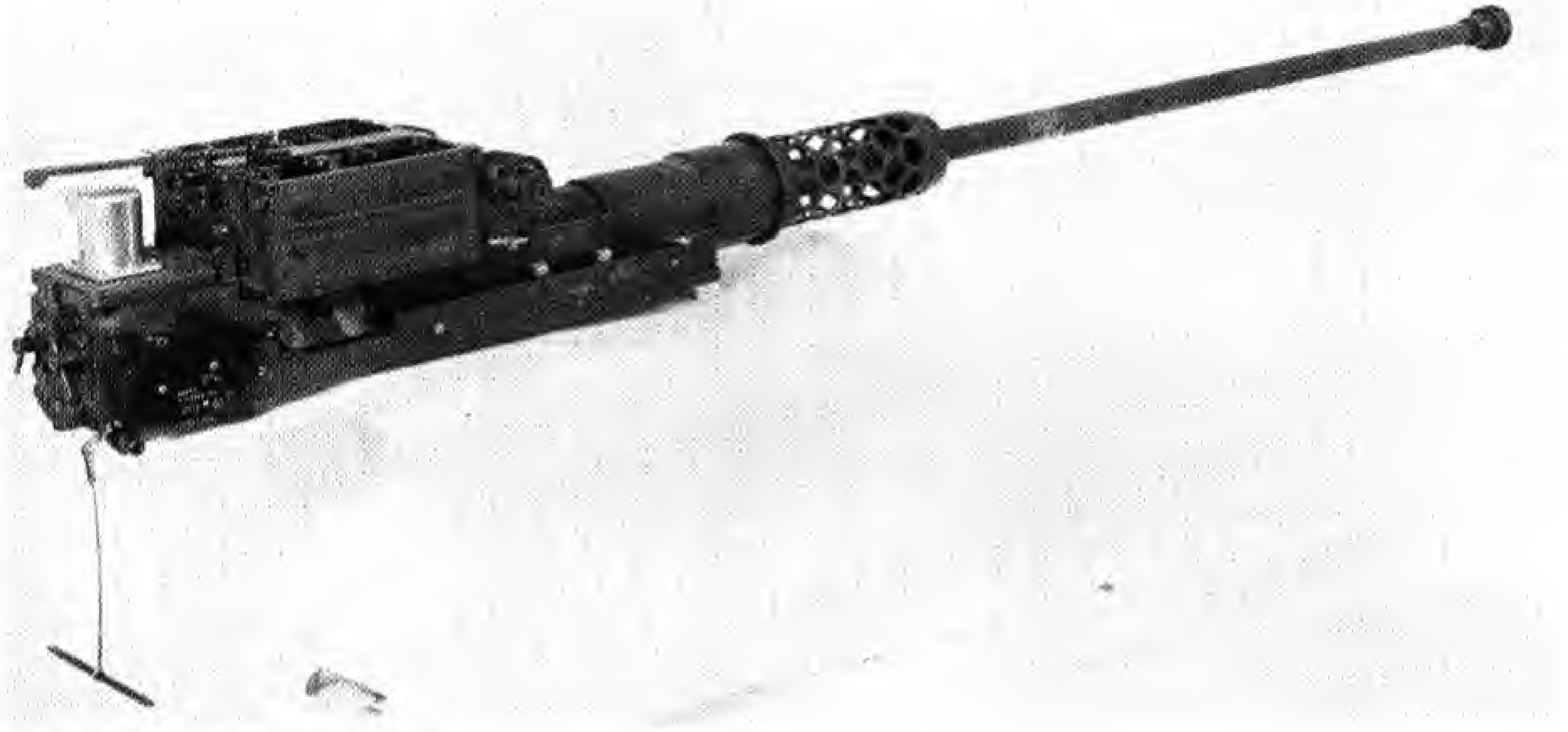


20mm M50 Series, U.S. Percussion Primed Ammunition. (Photo courtesy of Woodin Laboratories.)

Chapter 35

27.5mm GE-127A AND GE-127B SINGLE BARREL MACHINE GUNS

GENERAL ELECTRIC



27.5mm General Electric GE-127A

History

General Electric initiated work on the GE-127A model gun in August of 1968. An improved version, GE-127B model, was developed in 1972 to be the G.E. candidate in a U.S. Army test at Aberdeen Proving Ground in 1973 to select the gun to be referred to as the Bushmaster gun.

The purpose of this program was to fabricate a 27.5mm Single Barrel Machine Gun to meet the Bushmaster weapon specifications as mandated by DOD.

The ammunition development was done primarily by Aerojet-General Corporation. General Electric, Aerojet-General and Amron Corporation worked together to establish compatibility between the weapon and the ammunition.

The link design was done by Roy Sanford Company in conjunction with General Electric and link production was by Mechanical Products, Teledyne Company.

The program produced one prototype gun, four different 27.5mm rounds and development of the 27.5mm weapon, link and ammunition progressed successfully. During the last 1,000 rounds fired only one malfunction occurred which was considered acceptable for a system which had previously fired during an endurance test a total of 3,600 rounds.

Description and Purpose

The gun was to be a scale-up of the GE-120, Mk 29, firing any of the family of 27.5mm cartridges being developed for its use. The family was characterized by a 1.575 inch base diameter cartridge case and a 9.75 inch maximum overall length.

The GE-127A was operated at a rate of fire of 550 rounds per minute, continuously variable from 100 rounds per minute through an external control box which pulses the firing solenoid.

The gun had either semi-automatic or automatic fire at the gunner's option and was capable of one-man operation. A manual trigger, feed selector and charging mechanism was incorporated in the weapon as well as mounting provisions made for a remote controlled feed selector, power charger, and trigger solenoid.

The GE-127A had a dual ammunition feed mechanism with a manual feed selector and the action of the selector was such that a change of feed selection affected the succeeding shot fired.

The ammunition for the GE-127A is a new design 27.5mm family developed by Aerojet General Corporation and the four rounds are "High Explosive," "Armor Piercing Discarding Sabot," and a Simulator for each.

Characteristics

Bore Size	27.5mm
Muzzle Velocity	3650 fps
Rate of Fire	550 spm
Basic Systems of Operation	Recoil
Mode of Feeding	Instantaneous Selection
Power Source Feed System	Recoil
Feed System	Sprocket Type
Type of Feed (location)	Link
Type of Ignition	Percussion
Type of Charger	Manual
Initial Extraction	Downward
Type of Fire Control	Solenoid
Manufacturer	General Electric
Ammunition Type	APDS, HE, MF
Overall:	
Length	115.7 in.
Width	9.4 in.
Height	11.1 in.
Weight (with feeder)	262 lbs.
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Manual
Removal of Barrel	Quick Change

Cycle of Operation

The weapon operates using the recoil energy of the fired round to cause the barrel, the barrel extension, and the bolt to move rearward. The bolt remains locked to the barrel through the barrel extension for .75 inches of dwell travel rearward from the battery position. This allows sufficient time for propellant pressure decay in the barrel.

The rearward motion of the components compresses the drive springs which provide the energy for their return stroke. Unlocking of the bolt starts at .75 inches of rearward travel and is completed at 1.13 inches.

The locks are mounted in the barrel extension and as the extension moves rearward, under the feeder (which contains fixed cam paths for control of the locks), the locks are moved out of the path of the bolt. Then the bolt and the fired case are accelerated rearward by means of an accelerator and cam arrangement. The case is pulled out of the chamber by the extractor mounted in the bolt.

Acceleration takes place from 1.13 to 2.13 inches of rearward travel of the barrel extension and barrel. The barrel contacts the barrel buffer and the rearward motion of the barrel and barrel extension is slowed to a stop within the available .50 inches of barrel buffer travel. The barrel and barrel extension pushed forward by the barrel buffer and barrel extension drive springs. The barrel and barrel extension are then stopped by the accelerator and held at the 2.13 inch point. The accelerator cam is buffered to absorb the energy of again stopping the barrel and barrel extension.

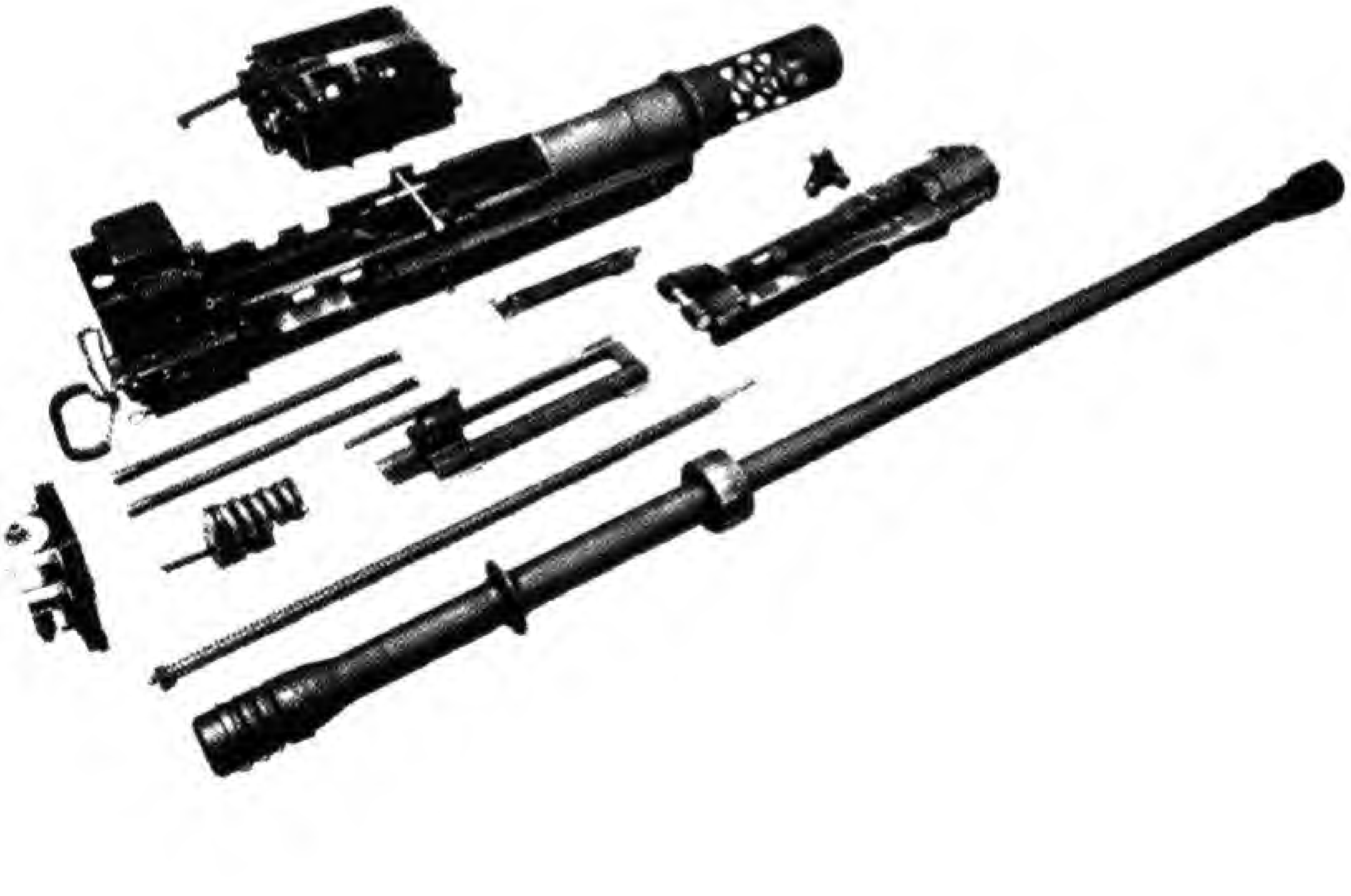
During the rearward travel of the barrel extension, the feeder is driven through one half of a feed cycle. This is done by the feed drive mounted in the rear of the receiver. The feed drive pin mounted in the rear of the barrel extension causes the feed drive to rotate as the barrel extension moves rearward. The outer pawls in the feed drive move downward, causing the feed wheel which is in firing position to rotate 60°. This motion advanced the belt one half a link pitch, sidestrips a round out of a link and places a round in the feed tray.

The bolt and fired case meanwhile are continuing rearward. The bolt passes under the round that has been placed in the feed tray by the feed action. The fired case contacts the ejectors which are spring mounted in the barrel extension. The case is then pivoted about the extractor and spun downward and out of the receiver. The bolt continues rearward.

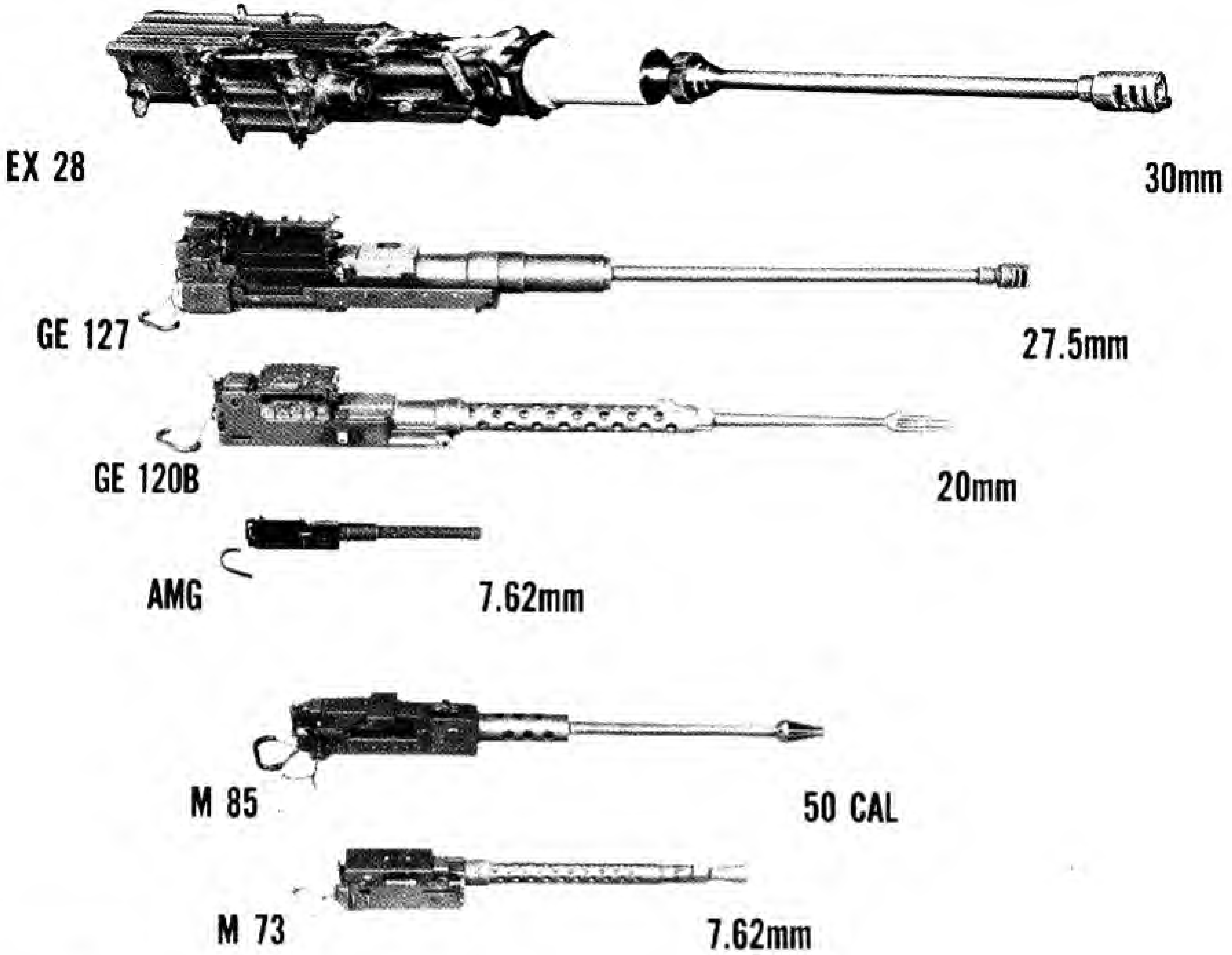
Single shot firing. The bolt contacts the sear causing the hook to move downward and the sear hook on the bolt passes over the sear allowing the sear to snap back up. The bolt contacts the bolt buffer which compresses and causes the bolt to stop. The bolt is then pushed forward by the bolt buffer spring and the bolt drive spring. The sear which is attached to the bolt buffer spring through the rear cap, engages the bolt and brings it to a stop. The bolt buffer spring pushes the bolt rearward again causing the bolt to strike the bolt buffer. The process is repeated until the bolt motion dithers out.

If automatic firing has been selected, the sear is held out of the path of the bolt by the solenoid. The bolt strikes the bolt buffer, is brought to a stop, and then driven forward. The rammer on the top of the bolt contacts the round in the feed tray providing the round with forward motion. Downward motion is accomplished by a ramp in the feeder which causes the round to be ramped down and into the barrel. The bolt strikes the accelerator causing it to rotate which releases the barrel extension and barrel allowing them to move forward driven by the barrel extension drive springs. The bolt slows on the accelerator and the barrel extension and barrel gain velocity from the bolt through the accelerator. The bolt and barrel extension come together 1.13 inches from battery position and they proceed forward together. The firing mechanism sear is contacted by the bolt at this point.

The locks in the barrel extension are actuated by



Major Parts of 27.5mm GE-127A



General Electric Family of Single Barrel Machine Guns

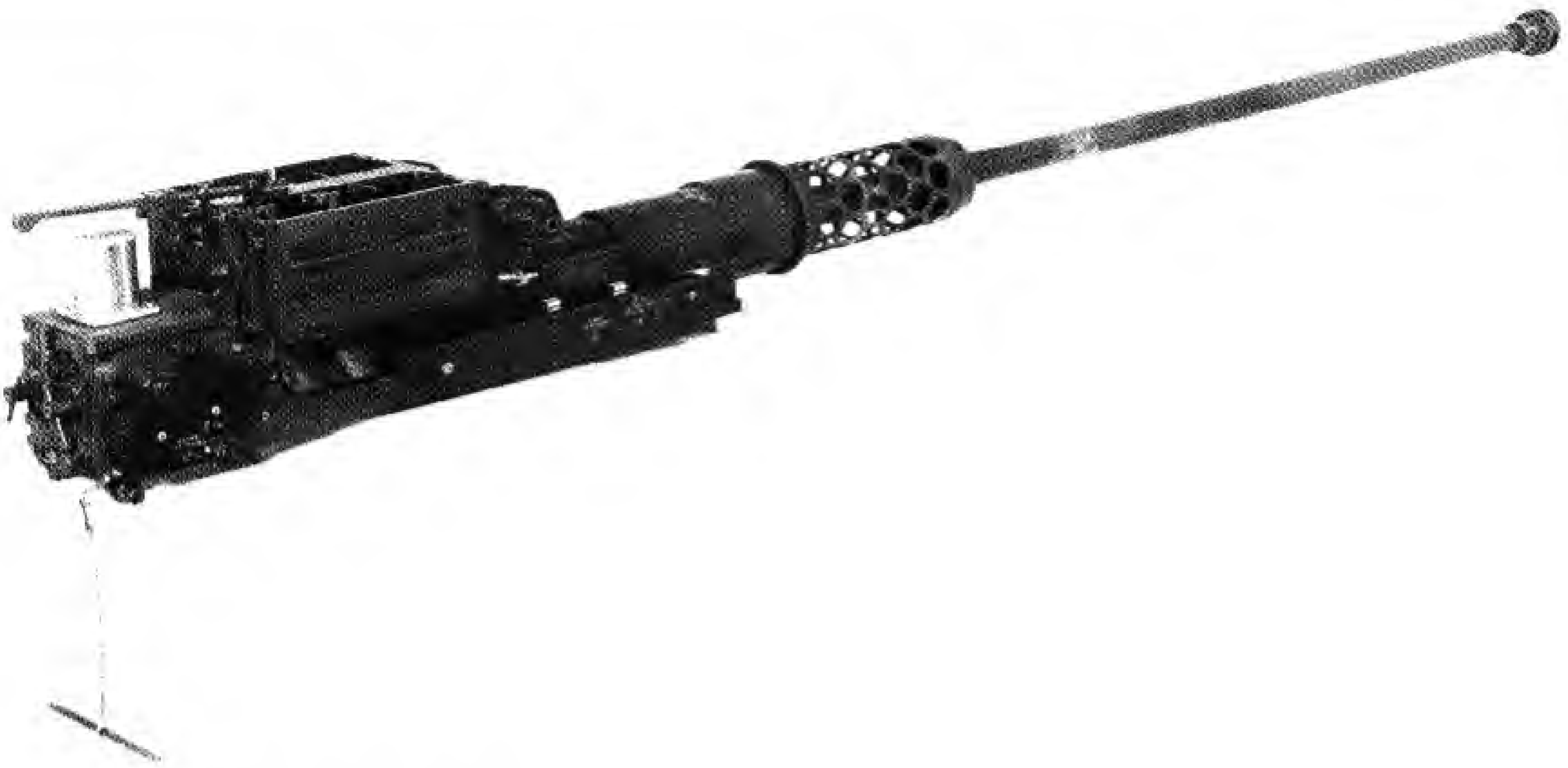
the fixed cams in the feeder. The bolt and barrel are once again locked together through the barrel extension and all move forward together.

During the forward travel of the barrel and barrel extension the second half of the feed cycle is done by means of the feed drive pin, feed drive, and feed pawl. As the barrel extension moves forward, the feed drive rotates and the inner feed pawls drive upward on the centerline side of the feed wheel. This causes the feeder to index another 60° which advances the ammunition belt one half a link pitch.

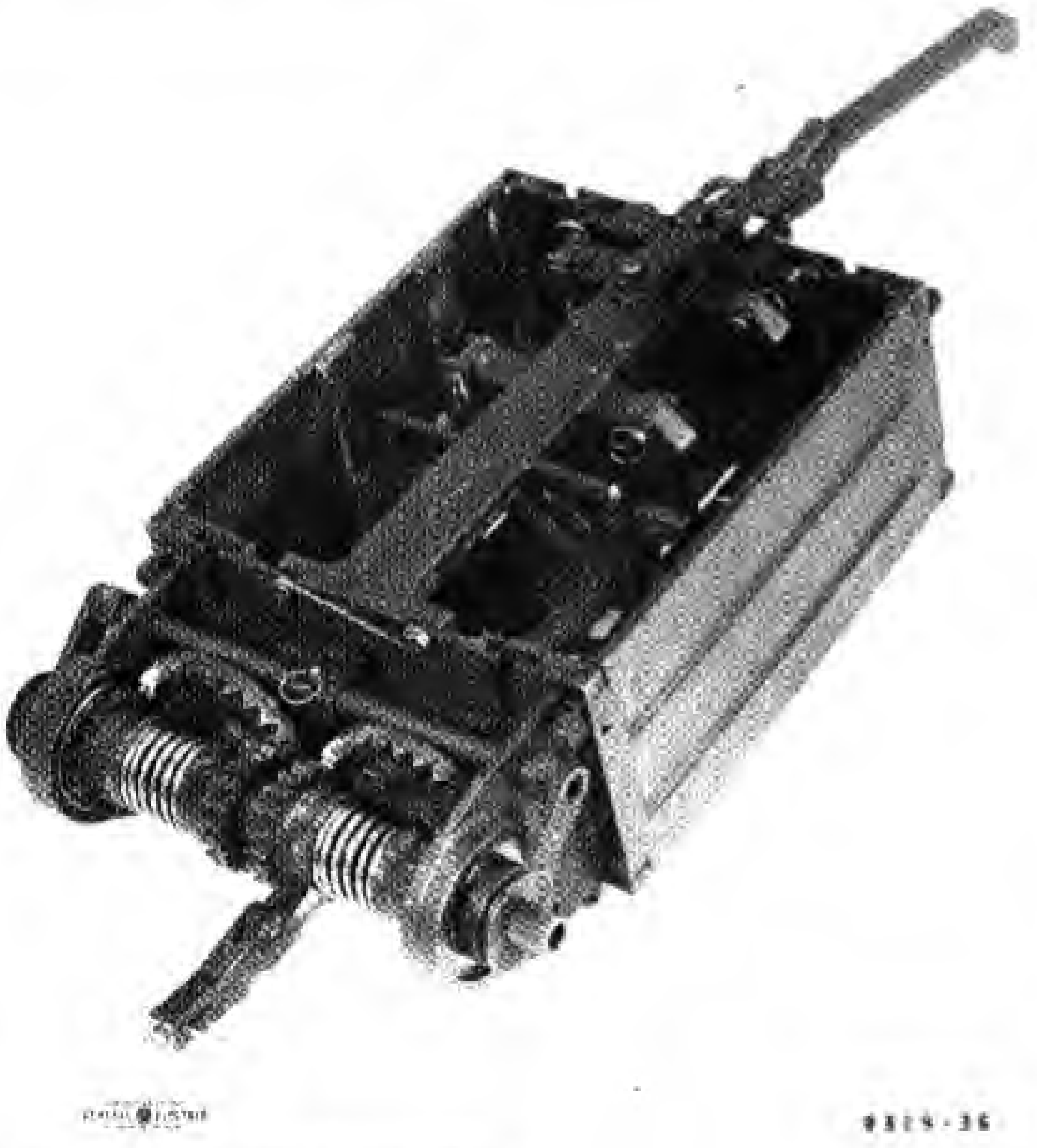
The firing mechanism sear which was contacted by the bolt at the start of the locking process, has been carried forward by the bolt causing the striker to compress the firing mechanism springs. At a preset distance before battery position, the firing mechanism sear is cammed down and off the bolt allowing the striker to be driven rearward by the firing mechanism springs. About the same time that the bolt, barrel extension, and barrel reach battery position, the striker contacts the hammer latch, disengages it and then strikes the hammer. The hammer then drives the firing pin forward and ignites the round and the cycle repeats.

The GE-127B model, which weighed 234 pounds compared to 262 pounds for the GE-127A, operated on the same principle as the GE-127A and fired the same 27.5mm family of ammunition. However, the gun receiver was shortened by relocating the trigger solenoid from the lack of the receiver to the top of the receiver immediately behind the dual ammunition feeder. The shortened receiver made the weapon more suited for turret installation.

Relocating the trigger solenoid as described neces-



GE-127B 27.5mm Automatic Machine Gun



Feeder Assembly (Front View)

sitated the relocation of the feeder drive to the front of the feeder. This resulted in a significant simplification of the feeder drive mechanism. The feeder sprocket shafts were indexed during gun operation by means of face gears being acted upon by dual opposed ratchetea spur gears mounted transversely to the face gears. The spur gears are rotated by means of a crank linked to the GE-127B barrel extension. Rearward motion of the barrel extension causes the inside spur gear to drive the face gear and its sprocket shaft 60° in rotation. During this action the outer spur gear slips due to the ratchet. During forward motion of the barrel extension the sprocket shaft is indexed 60° further by means of the outer spur gear driving on the face gear while the inside spur gear slips due to the ratchet. Of course this indexing action of the sprocket shaft accomplished the same action of advancing the belt, stripping the link, and placing a round in the feed tray as has been described in the operation of the GE-127A. The GE-127B feeder drive utilizing gears and splined shafts replaced the extremely complex pawl holder and pawl wheels used on the GE-127A feeder and resulted in the ideal wear characteristics associated with the rolling contact of inrolute gear teeth.

Test Results

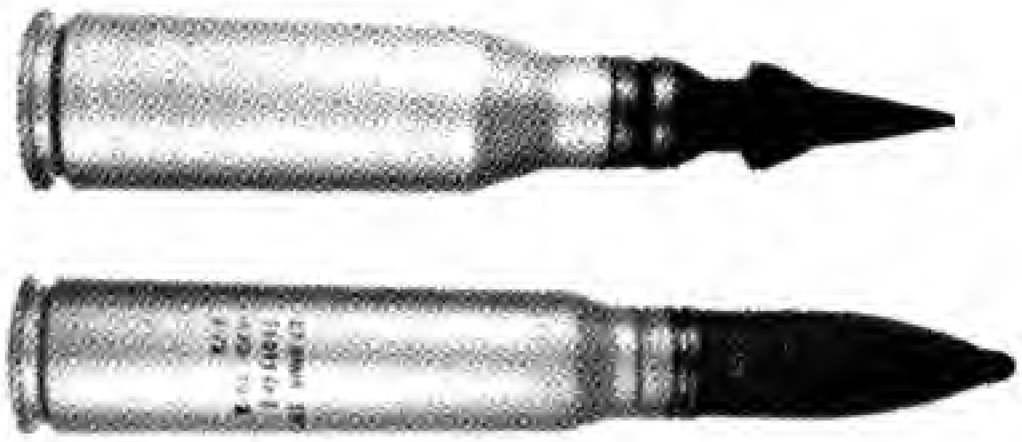
During the first 2520 rounds fired by G.E., there were seven failures to extract, three failures to fire, two link jams, six failures to eject, and 35 underrides and stubs occurred. Between rounds #2520 and 3600, there was only one malfunction, an underride.

During the development tests several problems were encountered. The most important being extraction failures. A program to determine the cause of and a correction for the failures to extract was conducted by Aerojet-General, Amaron, and General Electric.

The possible cause of the extracting failures was found to be the coating on the cartridges and was solved by an Amaron development called "Mcpok."

Ammunition

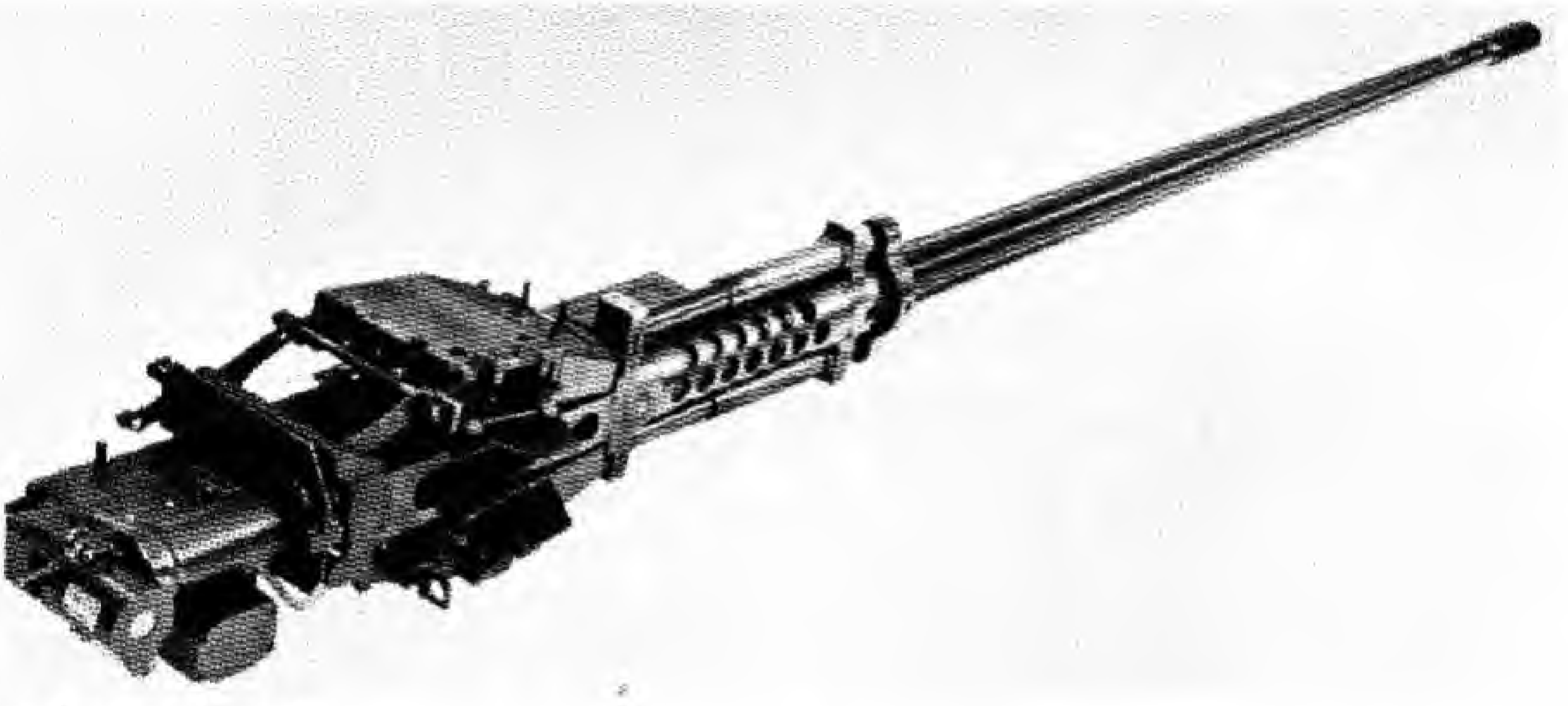
The ammunition for the GE-127 is a new design 27.5mm family developed by Aerojet General Corporation and the four rounds are "High Explosive," "Armor Piercing Discarding Sabot" and a simulator for each.



27.5mm Ammunition - Early Version (top), Final Version (bottom). Photo courtesy of Woodin Laboratories.

Chapter 36

25mm AUTOMATIC CANNON
OERLIKON, KB SERIES (KBA AND KBB)



25mm Automatic Cannon

History

Oerlikon began development of the KB series 25mm automatic cannon in 1969 when TRW ceased working on their 6425 automatic cannon. The Oerlikon KB guns are closely related to the TRW gun and appear virtually identical. The primary difference is that the Oerlikon guns are gas operated where the TRW 6425 was short recoil with a hydraulic accelerator.

Oerlikon was involved with TRW during the development of the ammunition for the 6425. Philco-Ford also began work in 1969 on improving the TRW 6425. Their gun is now known as the PFB-25 (Philco-Ford Bushmaster 25mm automatic cannon) and was a candidate for the VRFWS-S (Vehicle Rapid Fire Weapons System Successor). Oerlikon also worked with Philco on ammunition for the PFB-25.

Description and Purpose

There are at least two versions of the Oerlikon 25mm automatic cannon, KBA designed for turret use and the KBB designed for a mobile tripod mount. Both are belt fed, rotating bolt lock, gas operated, single barrel weapons. The main difference between the two versions is that the KBB has a recoil adapter to reduce trunnion forces. The KBB version is also mounted upside down so that the belts feed in from the top of the gun and the empty cases and links are discharged downwards. There is a one kilogram difference in weight of the gun due to a heavier barrel on the KBB version.

The main purpose of this weapon is to arm light armored vehicles with a weapon superior to existing 20mm weapons primarily against surface targets but also for anti-aircraft use.

Characteristics

Number of Barrels	1
Basic System of Operation	Gas
Firing Mechanism:	
Type	Percussion
External Power Required	None
Type of Feeder	Reciprocating
Method of Headspace	Fixed
Envelope Length	110 in.
Envelope Height	10.3 in.
Envelope Width	9 in. (feeds closed)
Receiver Length	47 in.
Receiver Width	9 in. (feed closed) 1.8 in. (feed open)
Receiver Height	10.3 in.
Barrel Dimensions:	
Length	85.5 in.
Weight	81.4 lbs.
Total Gun Weight	237.6 lbs.
Bore Size	25mm
Muzzle Velocity	1,100 m/sec, 1,325 m/s (APDS)
Rate of Fire	570 rpm

Cycle of Operation

The cycle of operation begins with the bolt seared to the rear and the first round in the feedway. The trigger is pressed down forcing the trigger catch up which releases the bolt and bolt carrier. The bolt and bolt carrier are pushed forward by the action of the compressed driving springs. As the bolt moves forward, it rams the cartridge into the chamber. As the cartridge is rammed, the extractor snaps into the extraction groove in the base of the cartridge. The bolt lugs enter the barrel extension and stop moving forward when the front of the bolt contacts the rear face of the barrel. The bolt carrier continues its forward motion and the action of its cam slot on the cam pins of the bolt rotate the bolt clockwise which locks the bolt into the barrel extension. While the bolt is being locked the firing pin, which is attached to the bolt carrier, moves forward relative to the bolt. When the bolt is fully locked, the firing pin strikes the primer and fires the cartridge.

The barrel, barrel extension, bolt and bolt carrier recoil within the receiver where the energy is absorbed by the spring packages on either side of the receiver. When the projectile passes the gas port a small amount of the propellant gases is tapped and acts on the gas piston thus driving the gas piston rod to the rear which in turn forces the bolt carrier rearward faster than the bolt. As the bolt carrier moves rearward relative to the bolt, the cam slots in the bolt carrier act on the cam pins of the bolt rotating the bolt counterclockwise which unlocks the bolt from the barrel extension. The bolt and bolt carrier now move to the rear until the bolt buffer is struck. As the bolt and bolt carrier move to the rear, the barrel and barrel extension are returned to their forward positions by the action of the springs of the recoil buffer. The empty cartridge case is extracted as the bolt and barrel separate and when the bolt strikes the bolt buffer the ejector rod pushes against the bottom edge of the base of the empty cartridge case which forces the case to pivot about the extractor so that the case is thrown out through the ejection port in the top of the receiver.

When the bolt rebounds into the bolt buffer, the sear slides under the trigger catch which lies in front of the sear. This catches the bolt carrier and holds it in the rear (open bolt) position.

In automatic fire, the trigger catch is held up from the sear by the trigger and the bolt carrier is not caught in the rear position.

Feeding is accomplished during the recoil of the bolt carrier. Cam paths on the sides of the bolt carrier act on cam pins in the feed carriers.

Description of the Assemblies

The Oerlikon KBA 25mm automatic cannon is a multiple-purpose weapon with the following characteristics:

Positively locked gas-operated gun, which is fired from the open breech position.

Fires, at choice, two different types of ammunition, the changeover being made by means of dual feed.

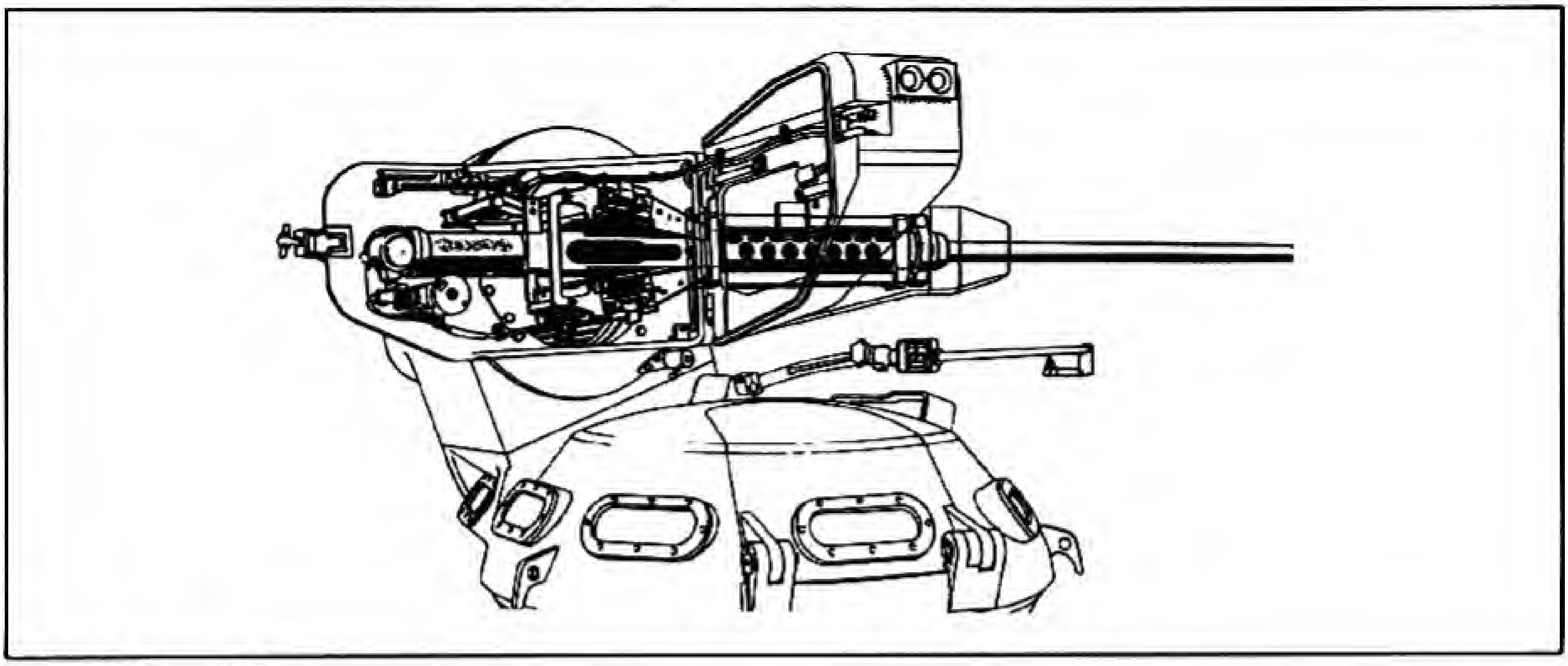
High output and certainty of hitting.

Operates reliably over a temperature range from -40° to +60° C, in heavy rain, in a sandstorm and even in ungreased condition of the moving parts.

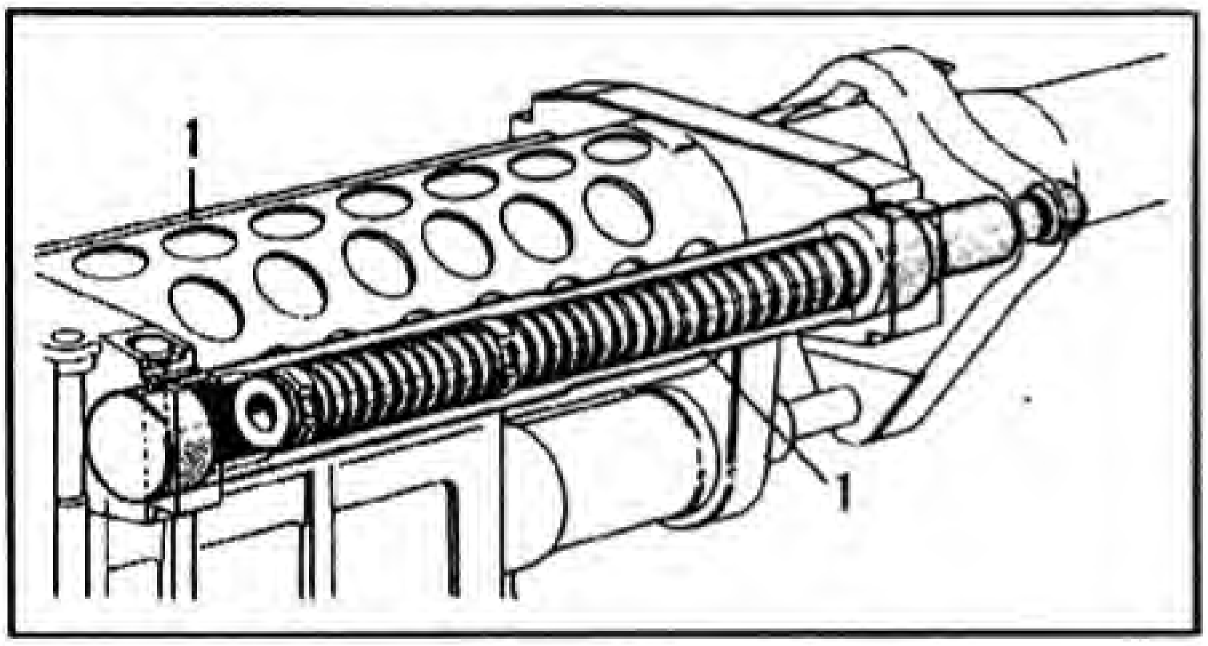
Weight and space occupied are those of a 20mm gun.

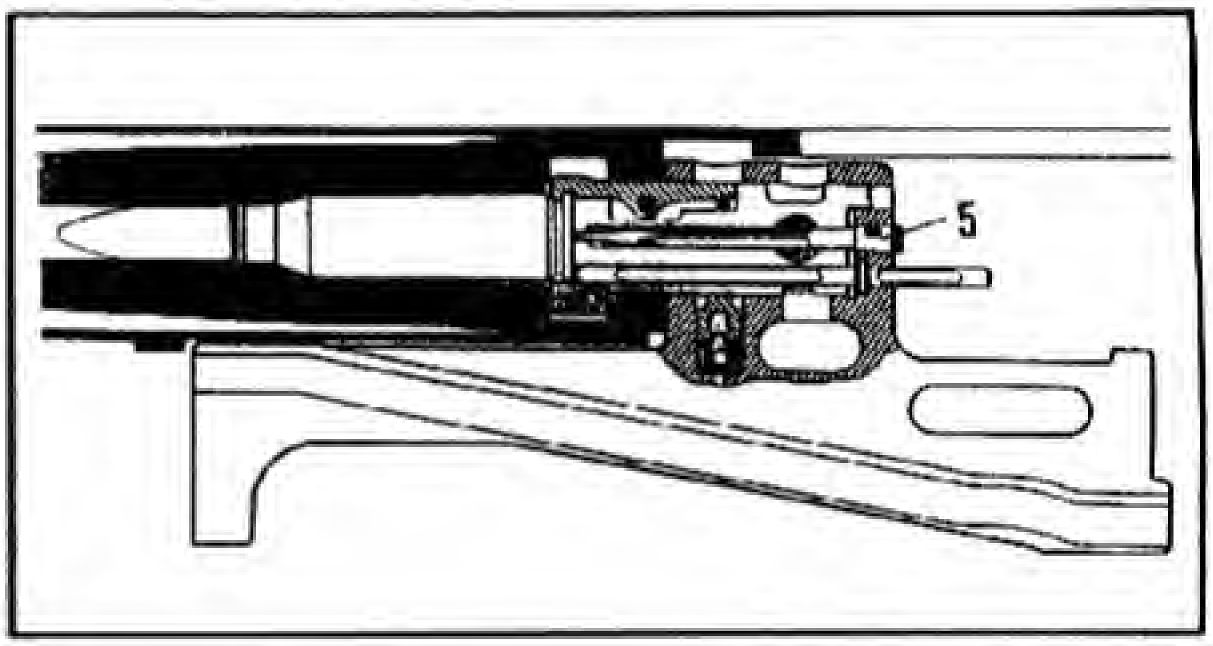
Simple handling and maintenance.

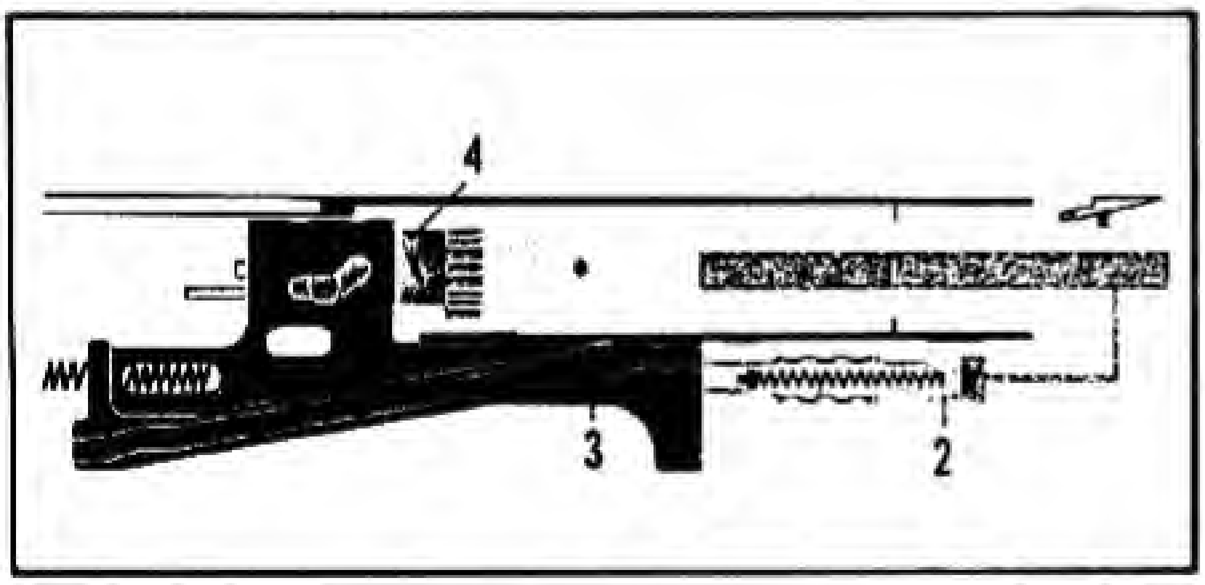
Can be stripped without tools under field conditions.

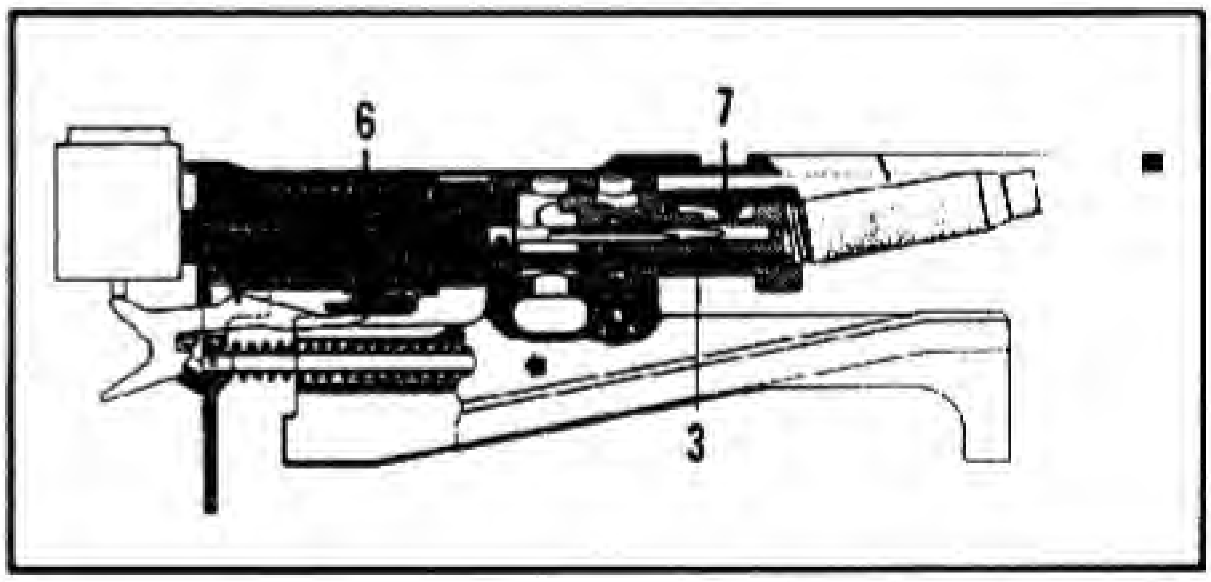


25mm Oerlikon KBA









Functioning

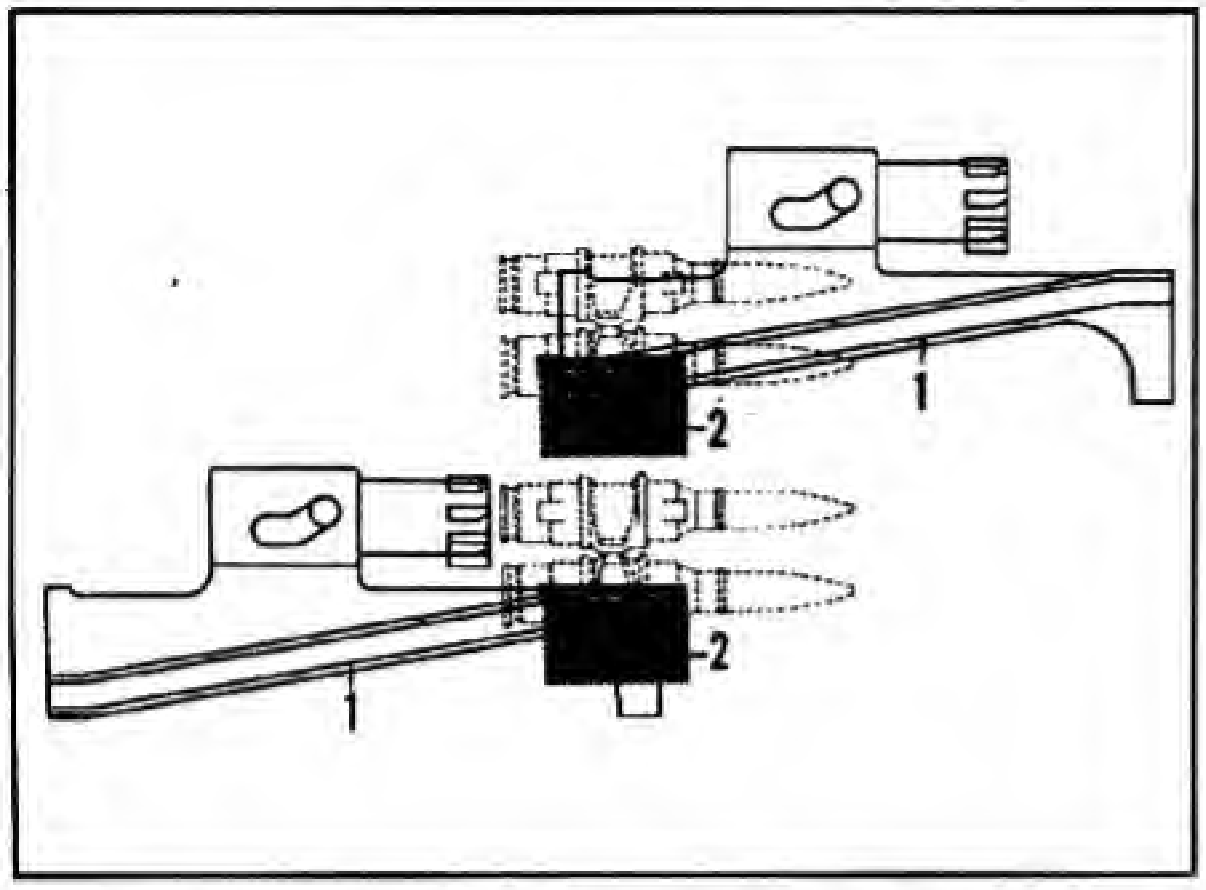
Lock and Discharge. After entry of the bolt lugs into the barrel extension, the bolt (2) is stopped by the rear end face of the barrel. The bolt carrier (4) continues forward; its cam pins (3) turn the bolt and locks the weapon.

The firing pin (5) following with the bolt carrier ignites the primer of the cartridge.

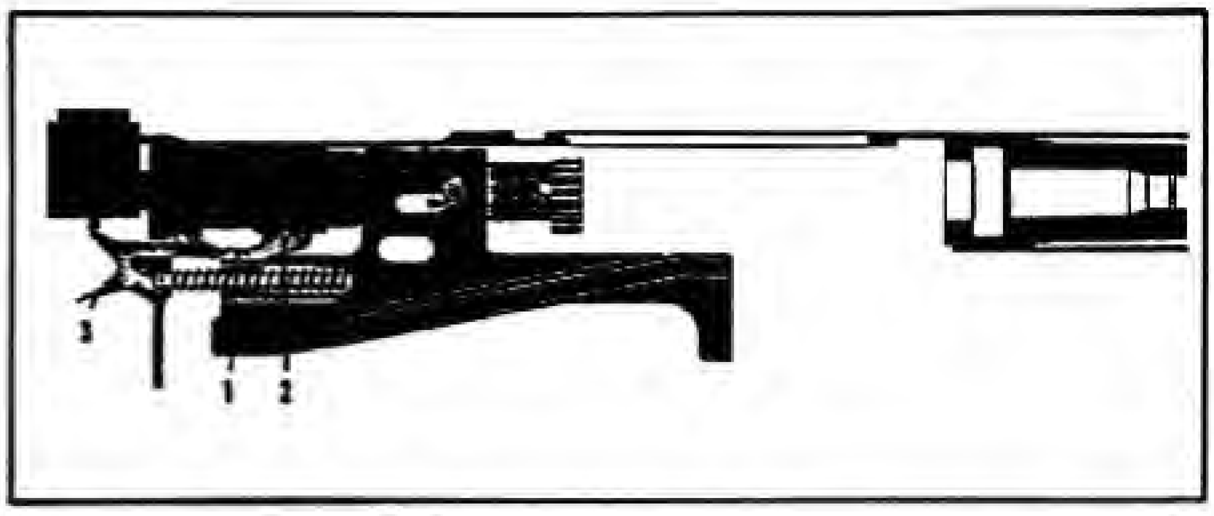
Unlock, Extraction, Ejection. The spring package (1) of the recoil buffer on the weapon housing takes up the recoil energy. Part of the energy is absorbed by the belleville springs. The barrel is returned to its initial position by the remaining energy.

Once the round is fired and the shell has passed the gas port, the gas piston is accelerated. This acceleration is transmitted to the bolt carrier, which on recoil unlocks the bolt (4) by means of the cam pins. The empty cartridge case is ejected from the cartridge chamber by the residual gas pressure.

The ejector (3) is supported by the buffer (6) on the rebound of the breech, whereby the cartridge case is pushed out into the open by the extractor.



Feeding. During recoil, the bolt carrier produces, through its two-sided feed curves (1), a cross movement of the feed plates (2) and thereby the belt feed.



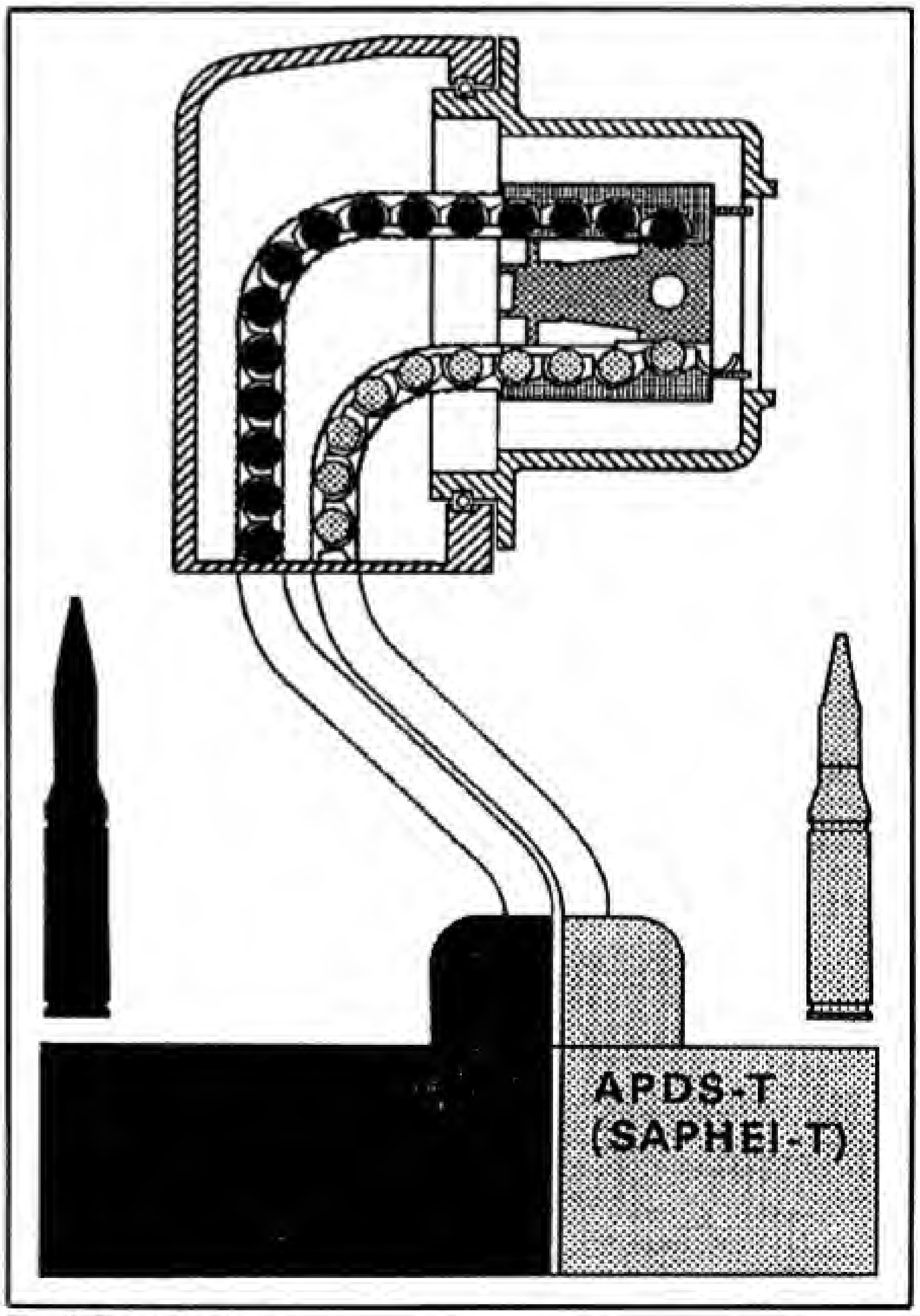
Searing. On the rebound of the breech on the buffer, its sear (1) slides through under the trigger catch (2). The latter lies in front of the sear. The open breech is caught. By actuating the trigger (3), firing can be repeated.

In continuous fire, the trigger catch remains withdrawn from the trigger. The breech cannot be caught and slides forward again, whence firing takes place again.

Selection of Ammunition Type

The manual control for the feed mechanism has three positions:

- Neutral: cannon ready while on the move
- Upper feed mechanism engaged: ready for firing 125 rounds of HEI ammunition
- Lower feed mechanism engaged: ready for firing 75 rounds of armour-piercing ammunition



Dual Feed System

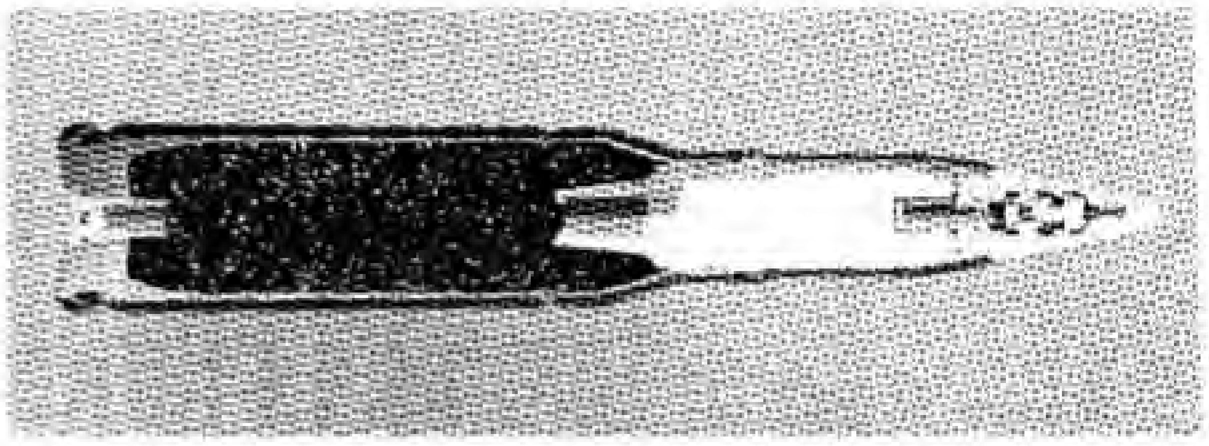
Ammunition Types

English marking	HEI-T	APHEI-T	APDS-T	TP-T
Oerlikon type	SSBL/K	PSBLH/B	PKLHT	SUL
Muzzle velocity	3609 fps	3510 fps	4800 fps	3609 fps
Weight of round	1.107 lb	1.111 lb	0.959 lb	1.100 lb
Weight of shell	6.349 oz	6.420 oz	3.704 oz	6.243 oz
Weight of explosive	0.917 oz	0.388 oz		
Self-destruction time	7 + 2 s	7+ 2 s		
Fuze type	KZB 311	BZB 318		
Tracer time	1.7 s	1.7 s	0.8 s	1.7 s
Tracer range	4265 ft	4265 ft	3281 ft	4265 ft
Time of flight for 1500 m	2.109 s	2.081 s	1.244 s	2.108 s

High Explosive Fragmentation Incendiary Shell

Type SLB, with tracer: NATO designation: HEI-T

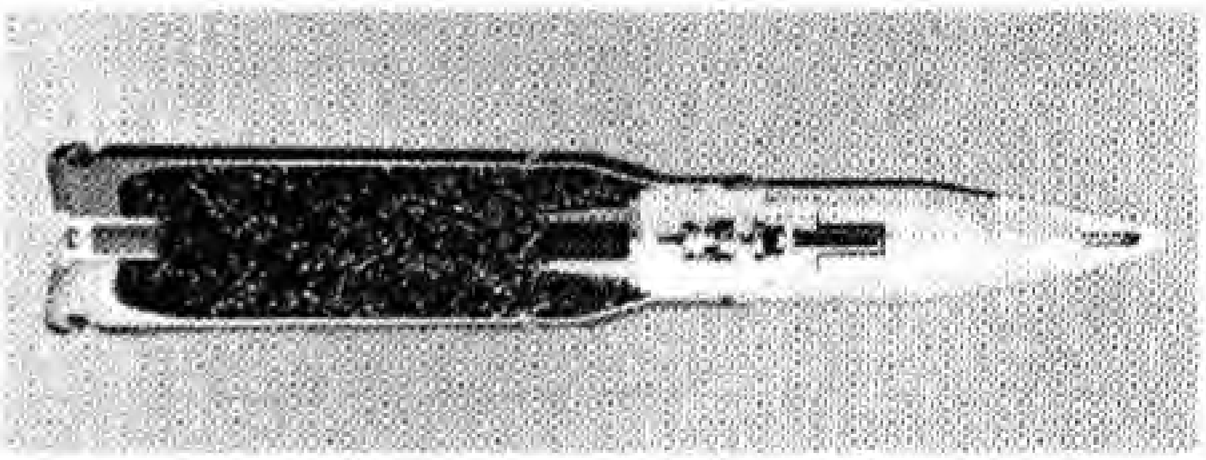
- For engagement of unarmoured air and ground targets
- With self-destruction nose impact fuze
- Fragmentation, explosive and incendiary effect



Semi-Armour Piercing High Explosive Incendiary Shell

Type PLB, with tracer; NATO designation: SAPHEI-T

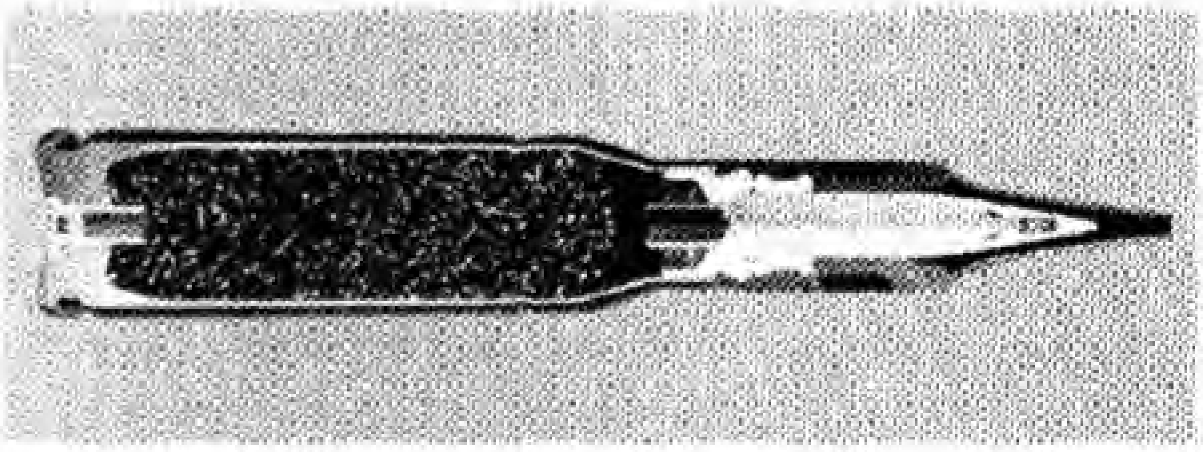
- For engagement of lightly armoured air and ground targets
- With self-destruction base impact fuze
- Armour-piercing shell with explosvie and incendiary effect



Armour-Piercing Discarding Sabot Projectile

Type TLB, with tracer; NATO designation: APDS-T

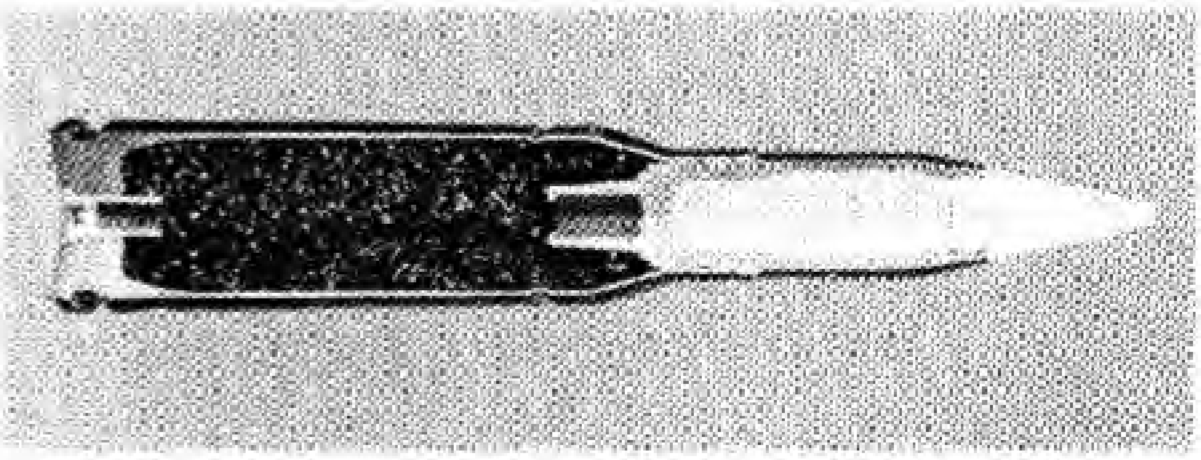
- For engagement of armoured ground targets
- Subcalibre heavy metal penetrator with discarding sabot, made of plastic material
- Armour penetration at 1000 m and angle of impact of 30°: 25mm



Practice Shell

Type ULB, with tracer; NATO designation: TP-T

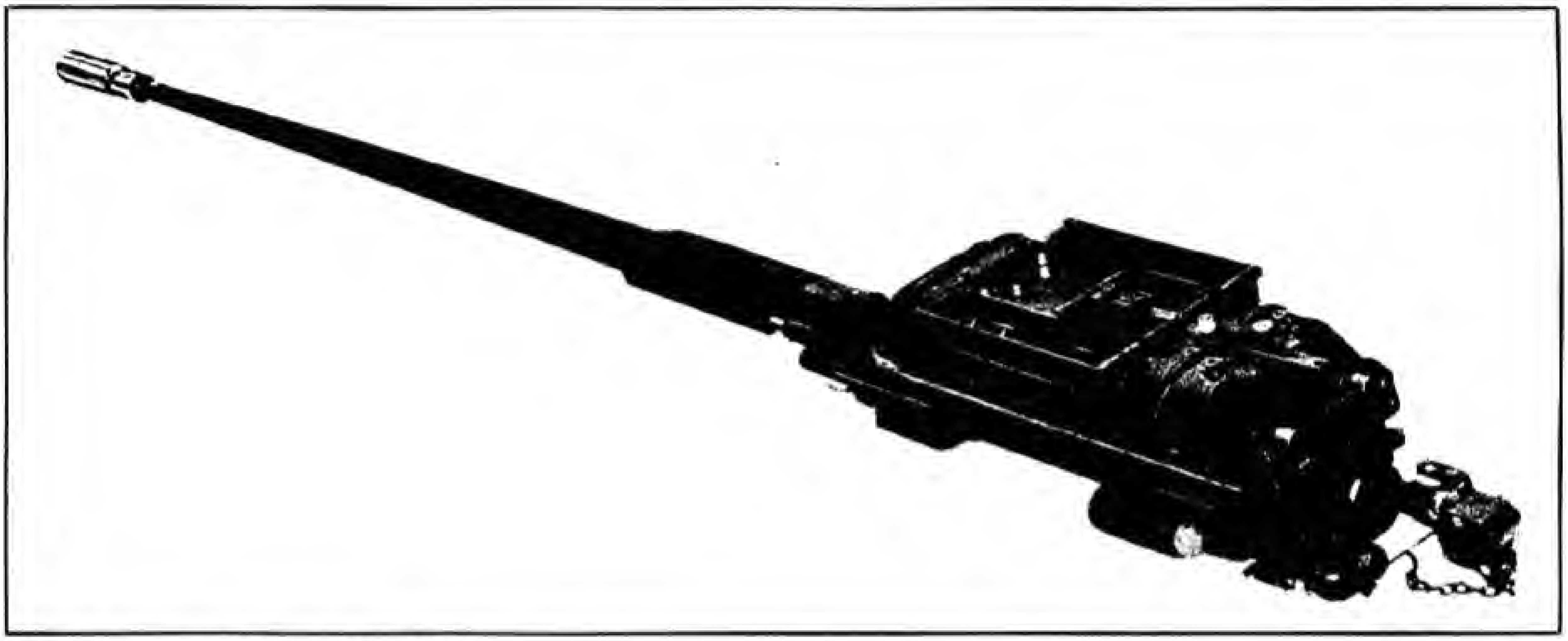
- For practice purposes
- Center of gravity, shape and ballistic properties correspond to those of the types SLB and PLB
- Without explosive charge



Chapter 37

20mm AME M693 AUTOMATIC CANNON

Direction Technique des Armements Terrestres (DTAT, France)



20mm Automatic Cannon AME M693

History

The design of the 20mm M693 began in September 1969 to comply with the needs for a weapon having a greater firepower than the 20mm gun type M621.

The Infantry Department of the Bourges factory proceeded to complete the design of the prototype which enabled them to set the production program in close cooperation with Tulle which is in charge of production.

The gun was adopted in 1971, and production began in 1972. By 1974, the M693 was in the field with the French Army and was designated the 21 F1 automatic cannon.

Description

The M693 20mm cannon was designed to be a weapon that would have an increased fire power due to its possibility to fire all cartridges with mechanical priming of the Hispano HS820 family and to select the desired terminal effect, being provided with a feed mechanism designed to switch over instantaneously from one type of ammunition to a second one.

Designed to be used in any position, the M693 20mm cannon can be mounted on many carriers (vehicle-aircraft) and be remote controlled, if a 24 V d.c. power supply is available, or locally controlled from a mount.

The main characteristics of the cannon are:

- Gas piston actuated.
- Possibility to fire many types of ammunition, including present types and types now under development, to cope with air or ground targets.
- Reduced overall dimensions and weight as compared with the present weapons offering comparable feed possibilities.
- A feed mechanism selecting instantaneously to fire any of two types of ammunition (piercing of

high explosive, for example);

- Low recoil strength and external geometry most favorable to installation on mounts and on vehicles.
- A new feed belt link greatly improving the bending, torsion and cohesion characteristics of the belts.
- Very easy disassembly and reassembly requiring no tools to make maintenance easy at the user's level.

Cycle of Operation

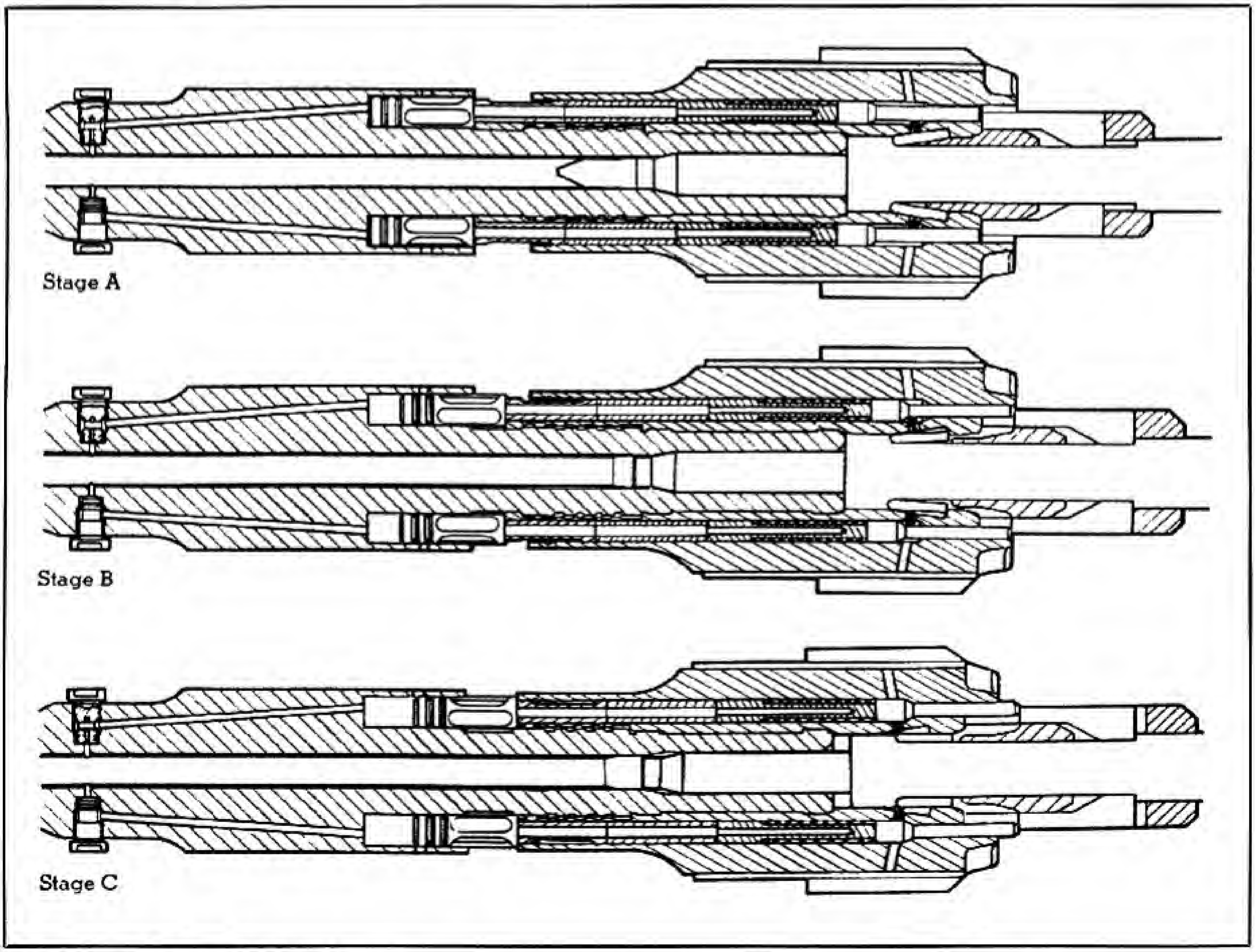
The basic gun, sliding in the cradle along the receiver guideways, consists of sub-assemblies that can be disassembled without tools:

- the barrel, with swivelling muzzle brake
- the receiver assembly
- the breech block slide
- the recoil springs and rearming assembly
- the triggering mechanism
- the triggering electromagnet
- the feed mechanism

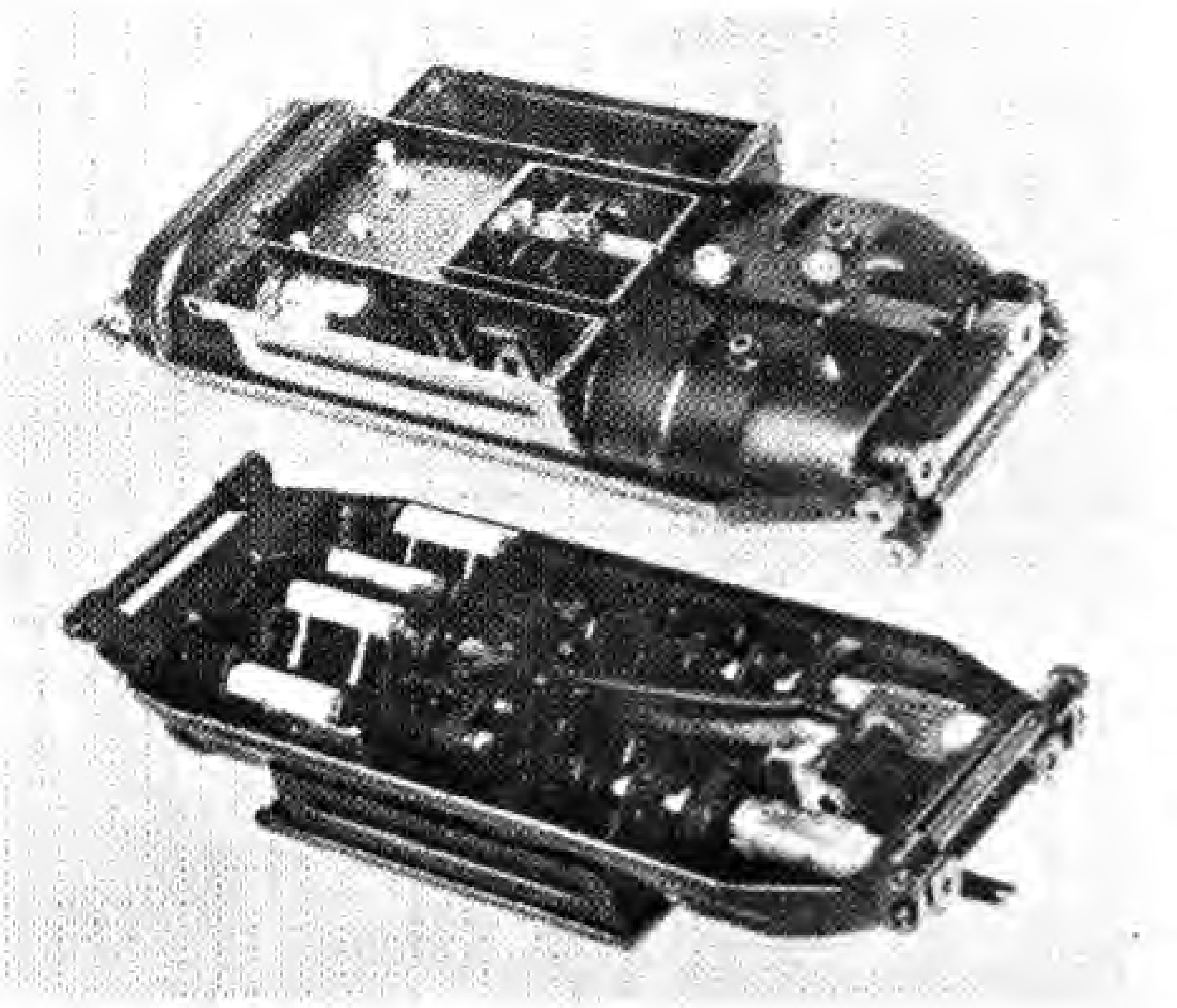
The 7° rifled barrel, made of a special nitrided steel, is equipped with a muzzle brake that can take two different positions.

It is provided with two side gas ports transmitting pressure to two side pistons that actuate the parts responsible for automatic functioning of the weapon.

The breech block slide assembly is responsible for percussion of the ammunition after two symmetrical crutches are locked, travels fully rearwards against two recoil springs the dampening effect of which is increased at the end of travel by a spring disk buffer assembly installed at the rear part of the receiver. Internal mechanisms of the weapon are arranged in such a way that all stresses are developed along the barrel centerline, all side stresses that could be detrimental to fire accuracy being prevented.



Sliding Breech Block Unlocking Stages

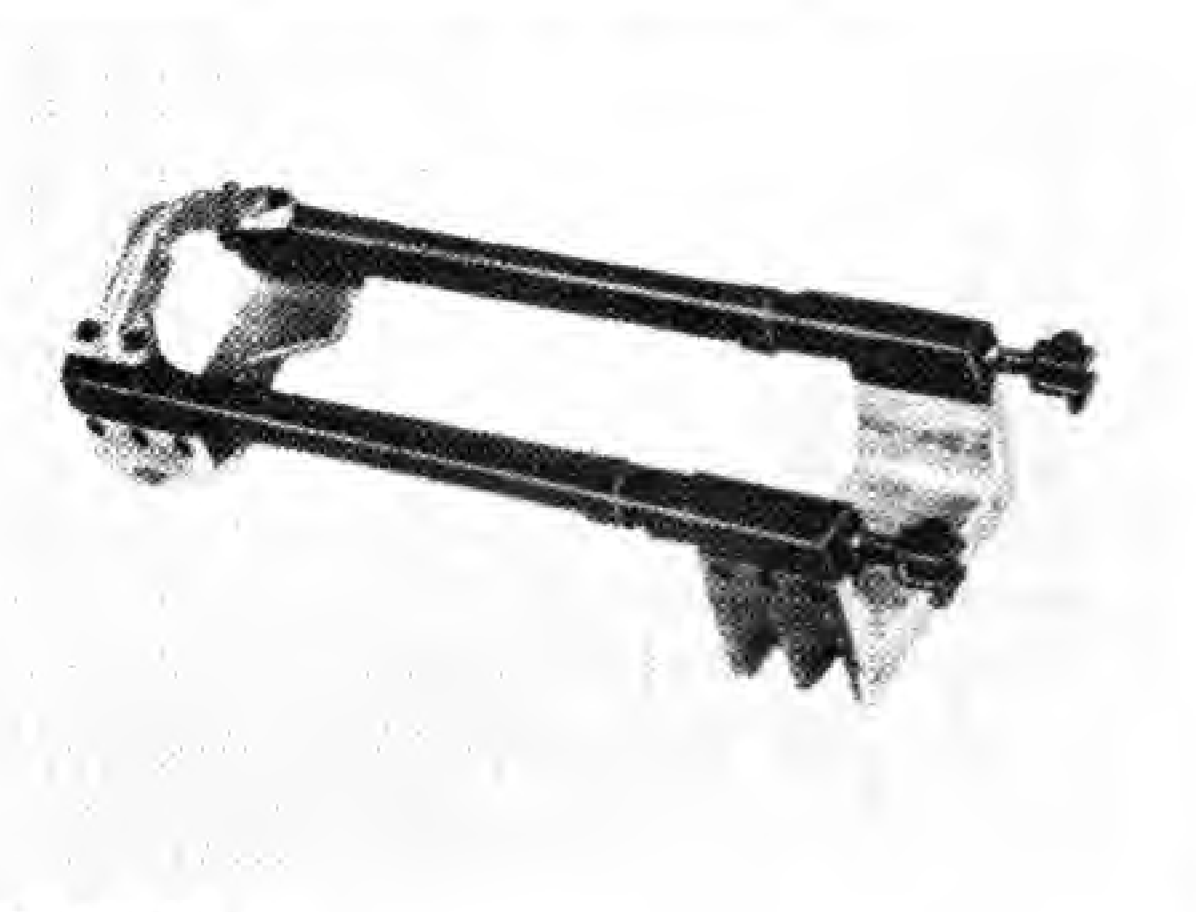


Feed Mechanisms

The feed mechanism is operated by the energy taken from the breech block slide assembly includes two side sprocket shafts each of them independently driven by a ratchet and pawl assembly installed rearward and remote controlled through a cable to select the cartridge belt that is to be fired. These cartridges are introduced into the weapon by two parallel flexible feed chutes between which sufficient room has been left for ejection of empty links. Such arrangement has been specially designed to position the belts to the rear of the weapon in as much as possible, thus making mounting of the weapon on a turret easier and reducing the space required by the flexible feed chutes and link ejection guides.

The triggering mechanism, actuated through an electromagnet when the weapon system is equipped with a 24 V d.c. power supply, is of the controlled type, which means that the sear is raised by direct action of the breech block slide assembly. The trig-

The M693 20mm Cannon is the Main Armament of the TOUCAN II Turret (TH 20) of the AMX 10 Infantry Combat Vehicle.



The Cradle

Characteristics

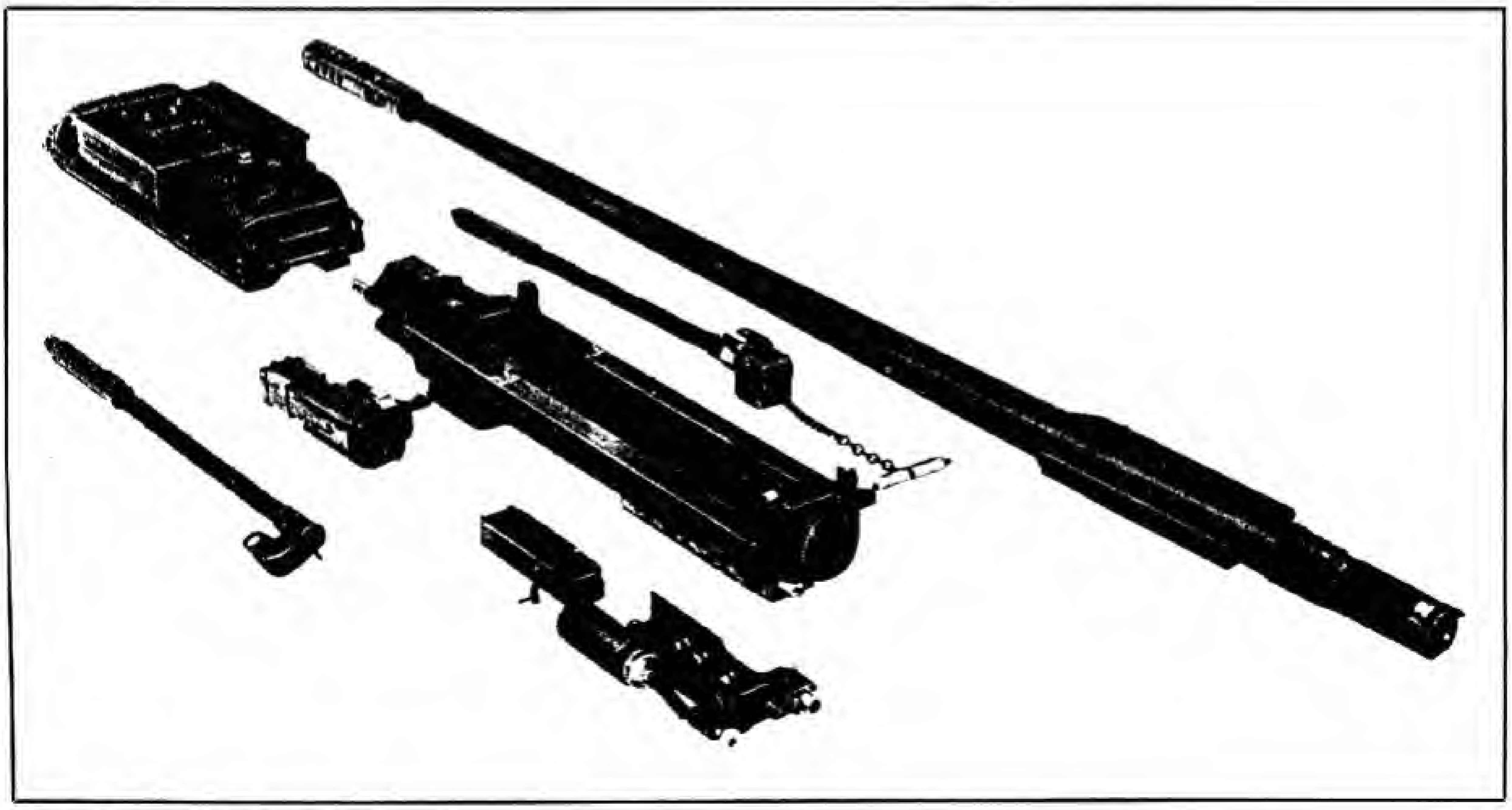
Cyclic Rate	740 rpm
Muzzle Velocity	3400 fps
Dimensions (with Cradle):	
Length	106.1 in.
Width	8.0 in.
Height	10.4 in.
	(9.2 inches without cradle)
Gun Weight	176 lbs.
Charging	Manual
Power Required	24 Volts D.C.
Trunnion Load (with adapters—cradle)	990 lbs.
Options - single shot; burst; full automatic	

gering mechanism comprises a selector switch, located rearwards of the weapon, for manual selection of one of three positions: single round - burst -safety.

The cradle is composed of two parallel guideways the distance between which is maintained by three light alloy spacers; these guideways on which slides the receiver surround the dampener assemblies that are symmetrical about the weapon centerline in order to prevent any detrimental torque.

Functioning of the dampener assemblies is very reliable under all conditions as they include only mechanical components. They are designed to provide a floating recoil during which the successive rounds are fired before counterrecoil is fully completed.

This type of recoil, used on a large part of the recoil mass travel entails very light stresses over the hooking trunnions of the cradle that are located at the front of the guideways with zero elevation and a load during burst firing that does not exceed 450 rpm.



Basic Weapon Sub-Assemblies

Ammunition

Cartridges are belt mounted with detachable links with connecting rings; These links similar to those used for the 20mm 621 weapon have been adapted to the standard cartridge case of the HS 820 model; they give the cartridge belts very good torsion and bending characteristics thus making the weapon perfectly fitted to the various types of mounts.

Another characteristic of this belt is to grip the cartridge at the level of the cartridge case groove which prevents any incidental unsetting of the cartridge belt when the munitions are being fed during the feed and firing cycles.

HS 820 Type Cartridges. The HS 820 family covers a large number of cartridges having either a single effect (piercing, incendiary, explosive) or a cumulated effect. The 20mm M693 weapon has been designed to fire these cartridges whatever their source may be. It is therefore possible, within the proposed range, to select the type of shell which is the most appropriate to the target to be fired at by the weapon. The choice is made easier by the possibility offered by the weapon feed mechanism to fire two types of shells.

The cartridge characteristics lightly vary with the types of shells and are listed here below:

- length of cartridge - 214 ins.
- weight of cartridge - 314 g
- weight of complete round - 375 g
- weight of shell - 120 to 125 g
- muzzle velocity - 609 ft/sec
- time of flight to 1,000 m - 1.25 s

Apart from the cartridges already produced in various countries, higher performance shells are now being designed. Among them, the most advanced project covers a subcalibre piercing shell cartridge, the piercing performance of which is considerably higher than the conventional shells one.

Subcalibre Piercing Shell Cartridge. A subcalibre type piercing shell was developed for the French Army who wanted to use the 20mm weapon against light armour vehicles.

The cartridge characteristics are:

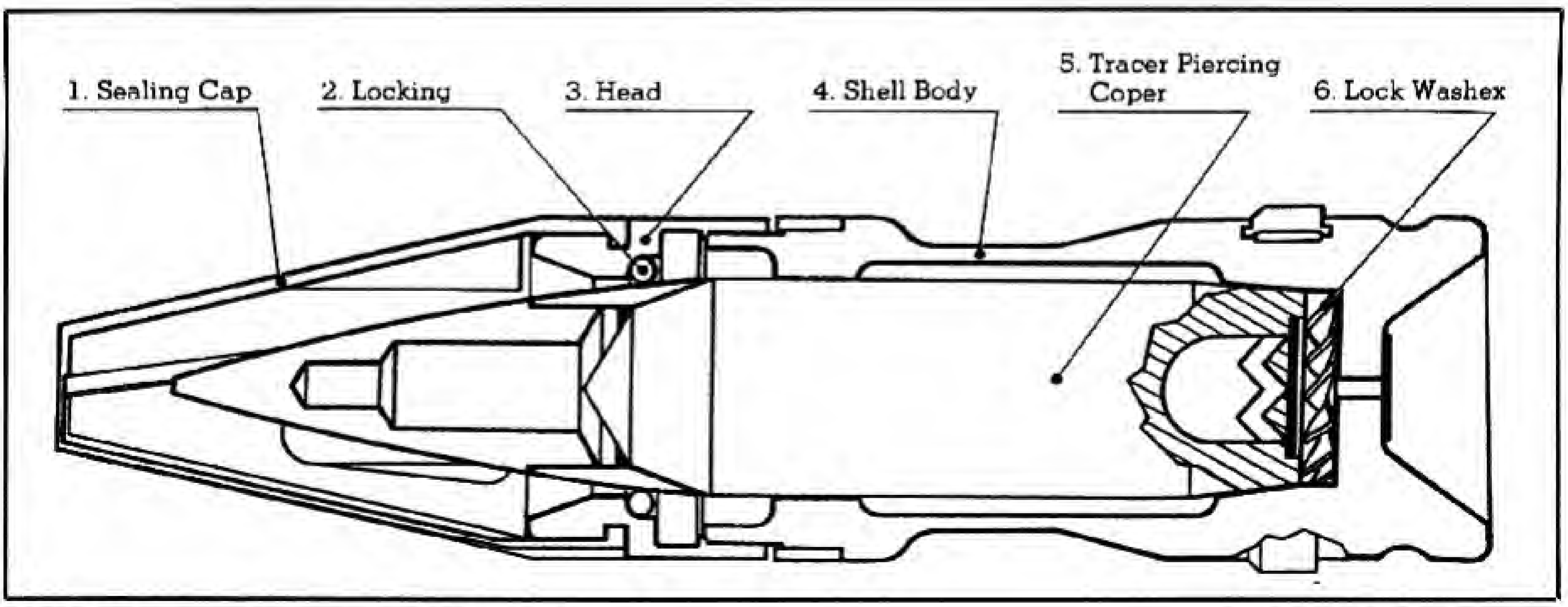
- muzzle velocity - 1.300 m/s
- time of flight to 1,000 m - 0.85 s
- weight of complete shell - 90 g
- weight of projectile in flight - 65 g
- weight of piercing device - 60.8 g
- operating pressure - 3,600 bars
- piercing power at 1,000 m - 20mm of armour steel under a 60° angle
- tracing distance - 1,700 m

Performance is greatly improved by the use of such a projectile.

The shell consists of a light alloy body equipped with a sintered iron rotating band; the 12.5mm dia. subcaliber projectile is made of tungsten carbide and a magnesium ballistic ogive is secured to it by means of a brazed steel ring.

The projectile is locked to the body by a flexible ring confined between the ogive and the head screwed to the body at the level of a steel guide ring.

The projectile is hermetically sealed by a plastic cap.

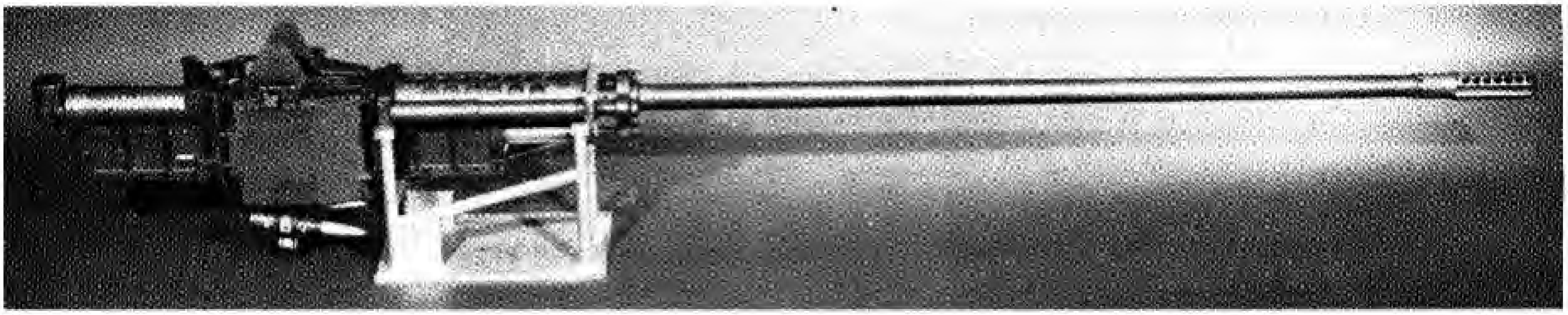


High Performance Armour Piercing Shell

Chapter 38

25mm AUTOMATIC CANNON PFB-25

PHILCO-FORD

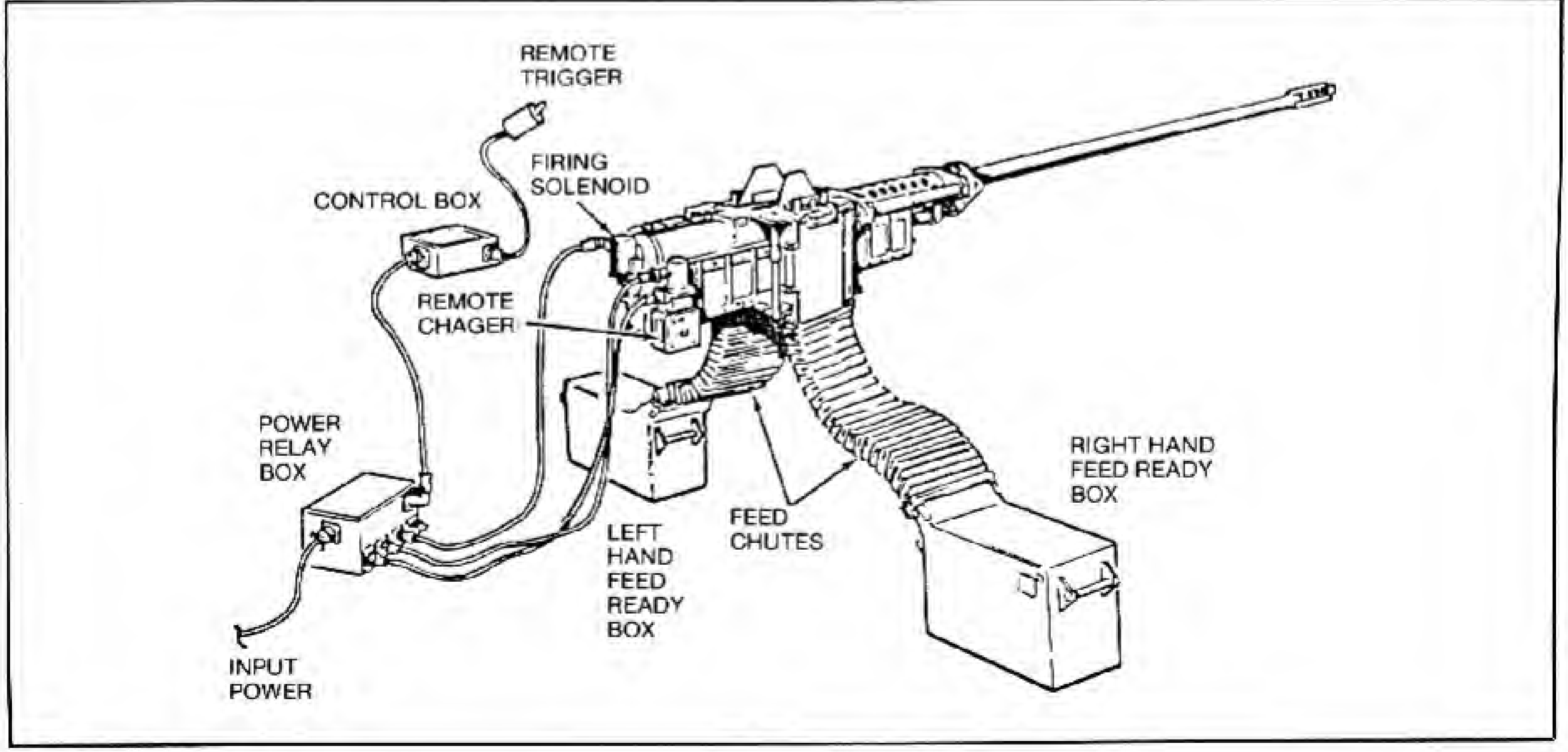


25mm Automatic Cannon PFB-25

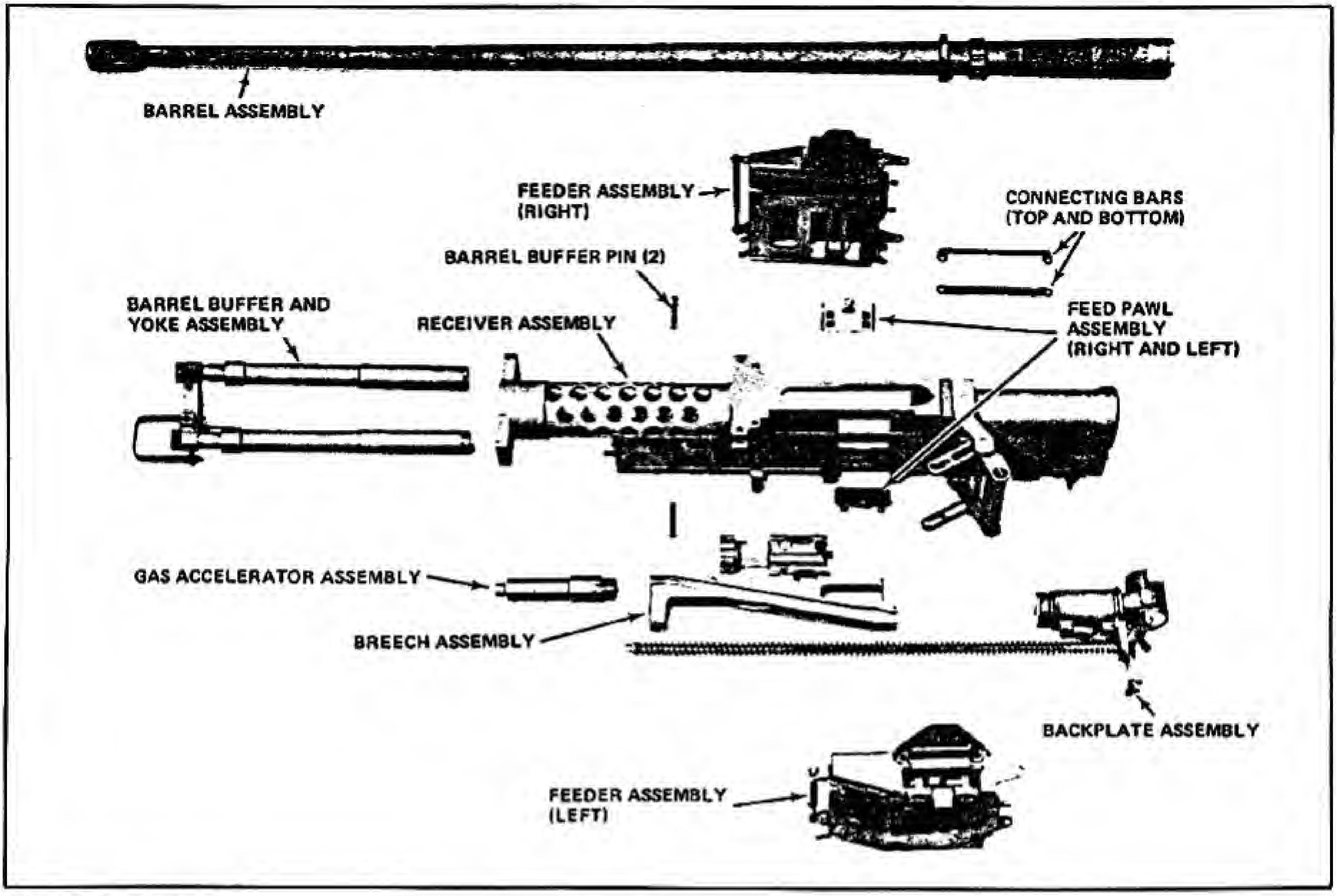
History

This weapon is a direct descendant of the TRW-6425. Philco began work on the weapon in 1969 when TRW sold the rights of the gun to them. The ammunition development for this weapon was primarily the work of Oerlikon and the characteristics of the ammunition are the same as those of the Oerlikon 25mm ammunition for their KBA.

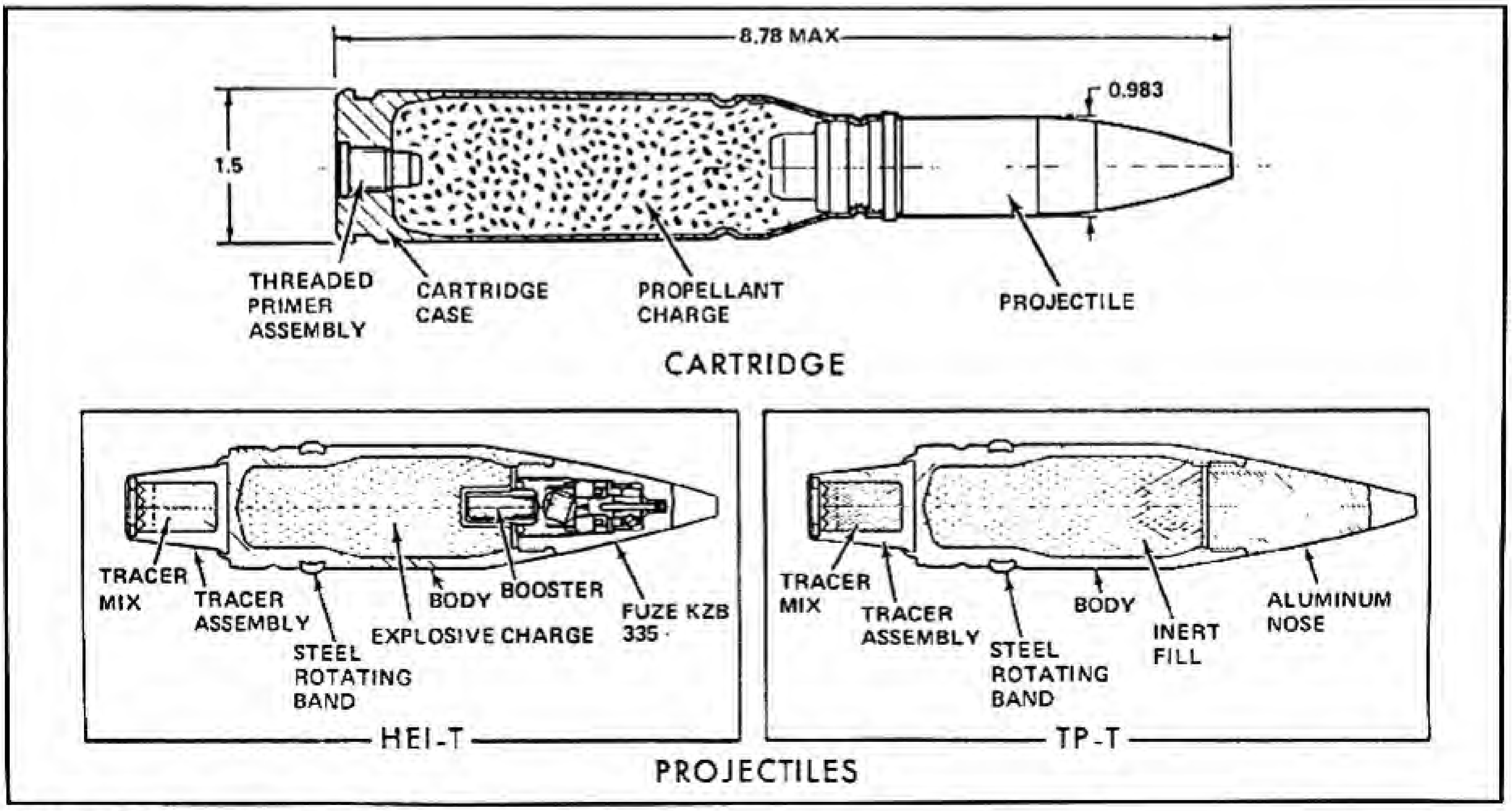
The PFB-25 has been selected as the self powered gun for the U.S. Army Vehicle Rapid Fire Weapons System (Bushmaster), hence the name PFB-25 which stands for Philco-Ford Bushmaster 25mm.


REMOTE TRIGGER
FIRING SOLENOID
CONTROL BOX
REMOTE CHAGER
POWER RELAY BOX
RIGHT HAND FEED READY BOX
FEED CHUTES
LEFT HAND FEED READY BOX
INPUT POWER

PFB Weapon System


BARREL ASSEMBLY
FEEDER ASSEMBLY (RIGHT)
CONNECTING BARS (TOP AND BOTTOM)
BARREL BUFFER PIN (2)
BARREL BUFFER AND YOKE ASSEMBLY
RECEIVER ASSEMBLY
FEED PAWL ASSEMBLY (RIGHT AND LEFT)
GAS ACCELERATOR ASSEMBLY
BREECH ASSEMBLY
BACKPLATE ASSEMBLY
FEEDER ASSEMBLY (LEFT)

PFB-25 Components


8.78 MAX
0.983
1.5
THREADED PRIMER ASSEMBLY
CARTRIDGE CASE
PROPELLANT CHARGE
PROJECTILE
CARTRIDGE
TRACER MIX
TRACER ASSEMBLY
STEEL ROTATING BAND
EXPLOSIVE CHARGE
BODY
BOOSTER
FUZE KZB 335
HEI-T
TRACER MIX
TRACER ASSEMBLY
STEEL ROTATING BAND
BODY
INERT FILL
ALUMINUM NOSE
TP-T
PROJECTILES

HEI-T/TP-T Ammunition

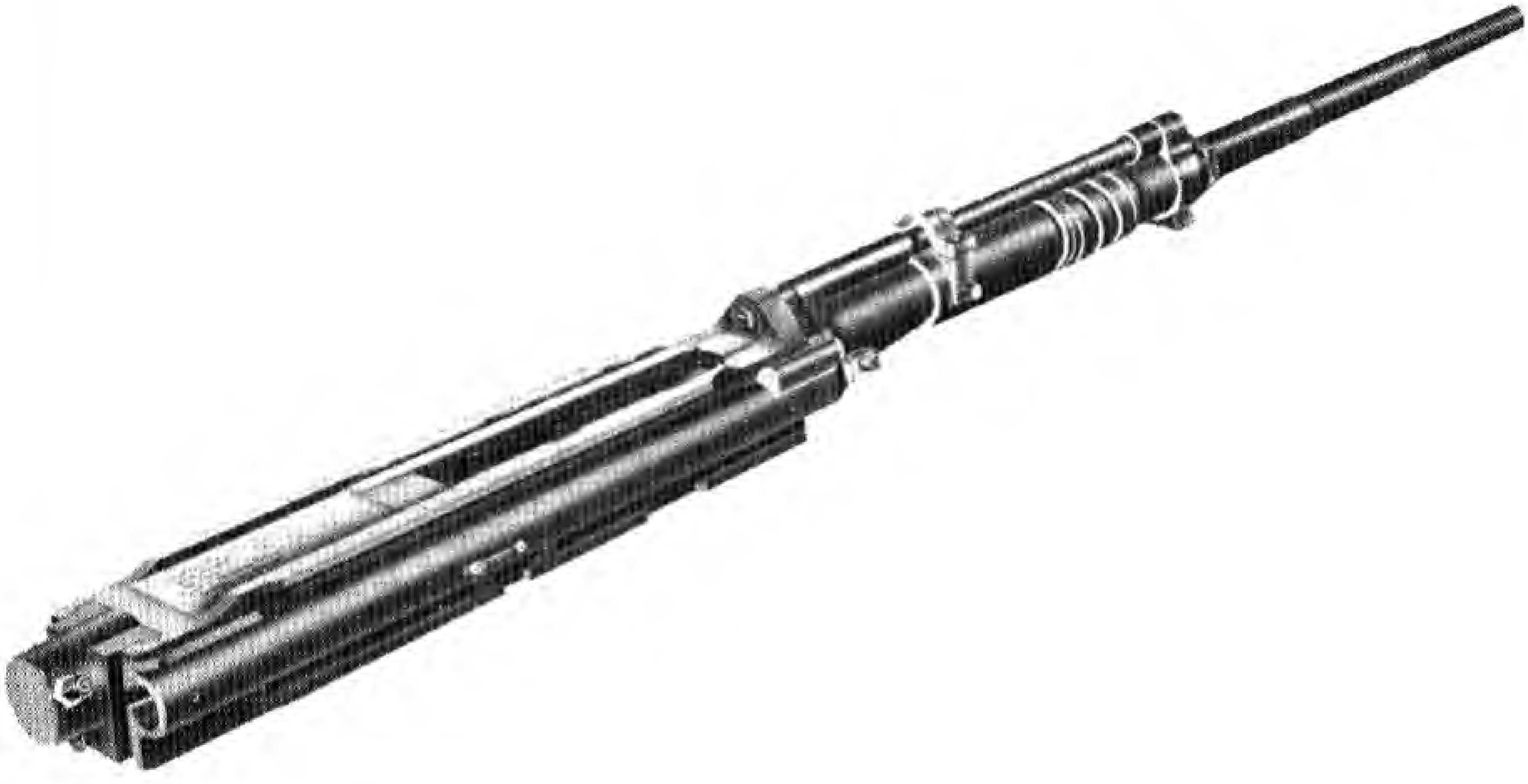
Characteristics

Bore Size	25mm
Muzzle Velocity	3500 fps
Rate of Fire	550 spm
Basic Systems of Operation	Self powered (Recoil with Gas Accelerator)
Locking System	Multiple Lug Rotary Bolt
Power Source	Feed System
Feed System	Dual Selective Feed (Remote or Manual)
Type of Feed (location)	Reciprocating
Method of Chargin	Remote or Manual
Mounting	No subcradle required, may be soft mounted
Variable Automatic	1-200 rpm
Semi-Automatic	Single
Recoil Loads	7700 lbs.
Manufacturer	Philco-Ford
Ammunition	AP-T Ammunition
Overall:	
Length	111 in.
Width	10 in.
Height	9.1 in. without deflectors
Weight	195 lbs. with charger and feed selector

Chapter 39

20/30mm Mk 12 ANTI-AIRCRAFT GUN

HISPANO - OERLIKON KCB



20/30mm Mk 12 Anti-Aircraft Gun

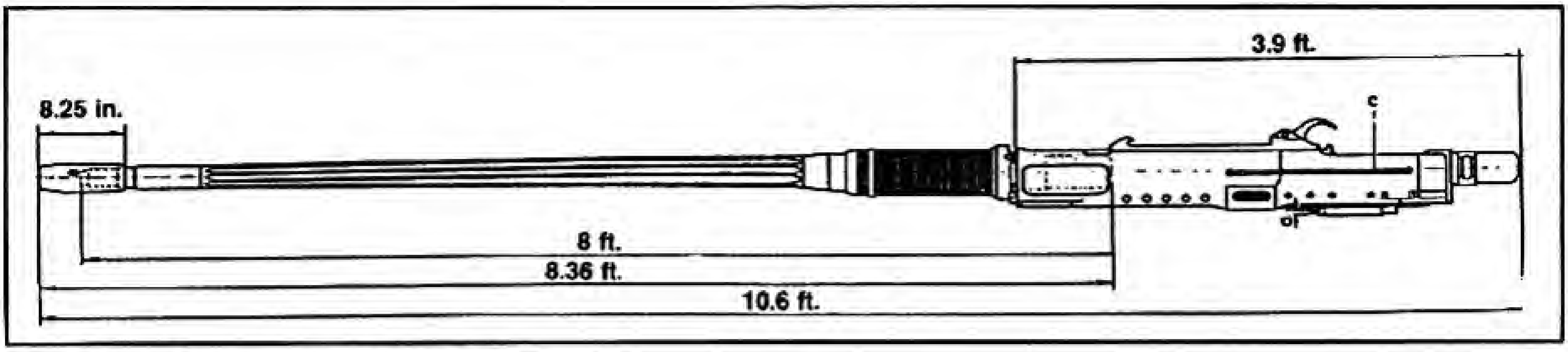
History

In 1936 the British commission became interested in the Hispano-Suiza Birkigt type 404. Negotiations for the purchase of six of these cannons by the British were completed in 1936, and the first gun was delivered in January 1937.

Early in 1937 the Hispano-Suiza Co. proposed the establishment of a Hispano-Suiza plant in England if given a token order for 400 cannons. This plant was opened in December 1938 under the name of British Manufacture & Research Co. The British produced a gun called the Hispano-Suiza type 404 in contrast to the designation identifying the model made in France, which was the Hispano-Suiza Birkigt type 404.

The initials of the British company were utilized to form the short identification "Mark" for the British-produced gun, and subsequent manufacture of the gun and development work to improve it were carried on under the designation "Mark" followed by a suitable Roman numeral.

In Canada, the Hispano-Suiza was manufactured



20mm Gun Mechanism Mk 12 Mod 1

under license by the John Inglis Co. of Toronto.

The story of the development of the Mk I and the Mk II is given in some detail in The Machine Gun, Volume I, Chapter 14.

Description and Purpose

The Hispano-Oerlikon KCB is a gas operated, propped lock, single barrel, air cooled machine cannon. The ammunition for this gun must be lubricated for proper functioning.

The gun itself is 10.6 ft., and weighs 297.6 lbs. The barrel is 8.4 ft. long and weighs 134 lbs. When the gun is fired the whole weapon, except for the feed mechanism, recoils approximately 1.5 to 1.9 inches. The 30mm weapon fires at a rate of about 600 rounds per minute and its standard ammunition has a muzzle velocity of 3,543 feet per second. The claimed practical range of 9.844 feet.

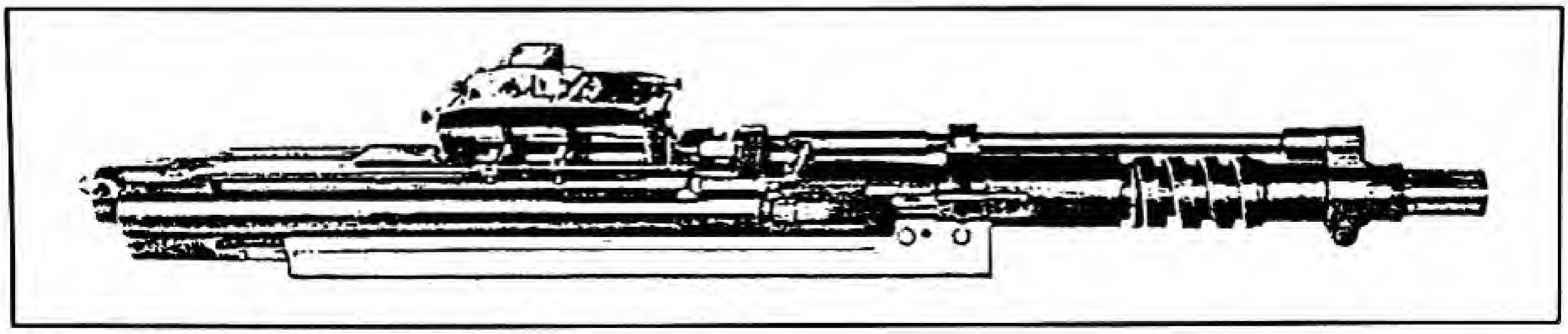
The primary purpose for this weapon is as a vehicle mounted anti-aircraft gun. Existing mounts include single ground mounts, and multiple naval and tank chassis mounts. Both link belt and clip replenished magazine feeds are available for the KCB.

Cycle of Operation

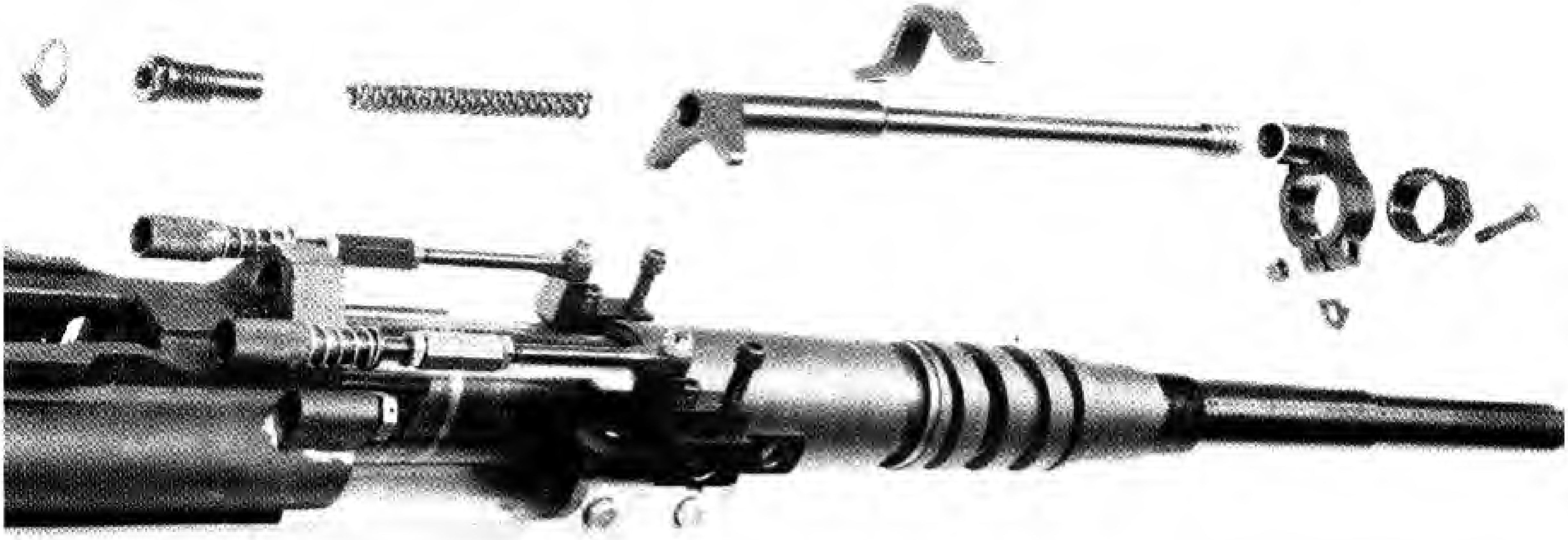
The cycle begins with the breech block open, and the driving spring compressed to its maximum. The sear being lowered by the trigger lever frees the breech block which is driven forward by the driving spring. The breech block pushes the cartridge out of the lips of the feed mechanism and rams it into the chamber. When breech block reaches the end of its forward run, the lock moves downwards, freeing the bolt slides which under the action of their springs, the lock the breech block. (The lock is secured by the bolt slides equipped with inertia blocks which protect against premature unlocking.) In this position the cartridge is fired. The whole of the weapon recoils and a gas operated piston drives the pushrods backwards. These pushrods cause the bolt slides to recoil and the lock is freed. The bolt slide springs are again compressed. Under the action of the residual gas pressure, the breech block pushes the lock into the unlocked position and starts to recoil. The cartridge case is extracted from the chamber by the

Characteristics of the Weapon

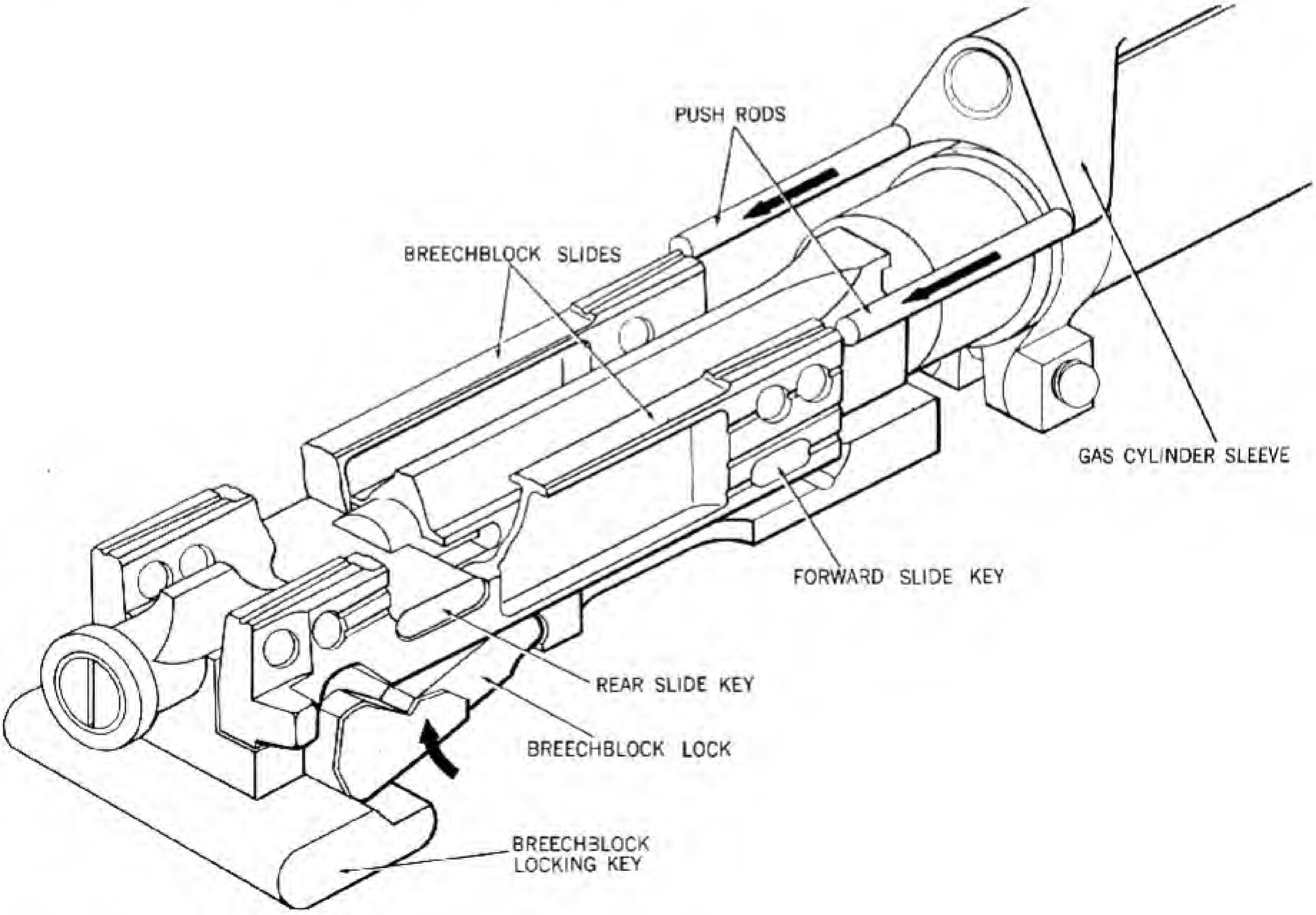
Calibre	30mm
Rate of Fire	600 rpm
Length of Bore (cal.)	75
Length of Weapon Complete	10.6 ft.
Length of Barrel Complete	8.4 ft.
Weight of Weapon	297.6 lbs.
Weight of Barrel	134.2 lbs.
Weight of Weapon Without Barrel	162.8 lbs.
Recoil of Weapon (b)	1.57 to 1.97 in.



20mm Gun Mechanism Mk 12 Mod 1



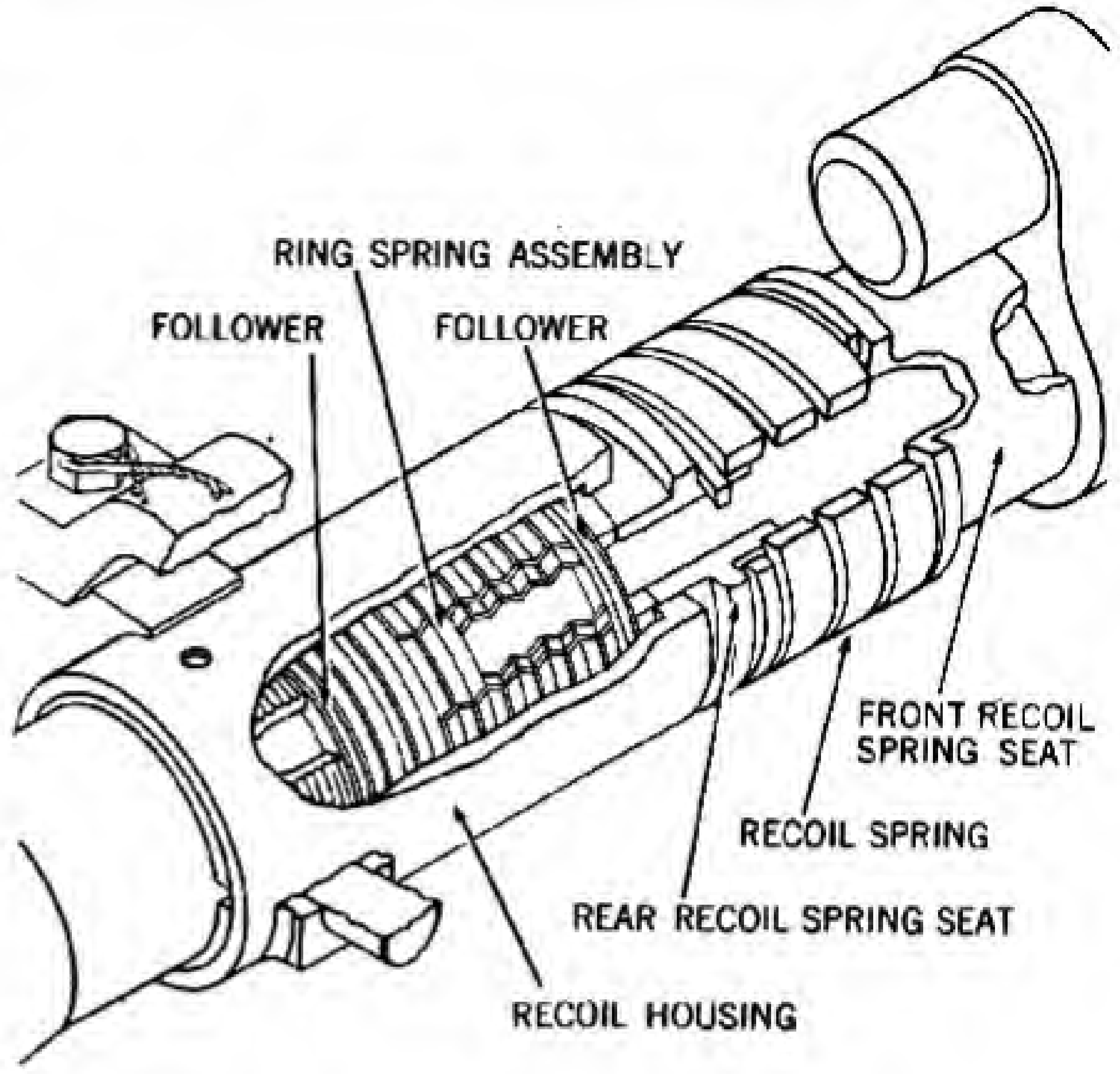
Exploded View of 20mm Mk 12 Mod 0 Gun Mechanism


PUSH RODS
BREECHBLOCK SLIDES
GAS CYLINDER SLEEVE
FORWARD SLIDE KEY
REAR SLIDE KEY
BREECHBLOCK LOCK
BREECHBLOCK LOCKING KEY

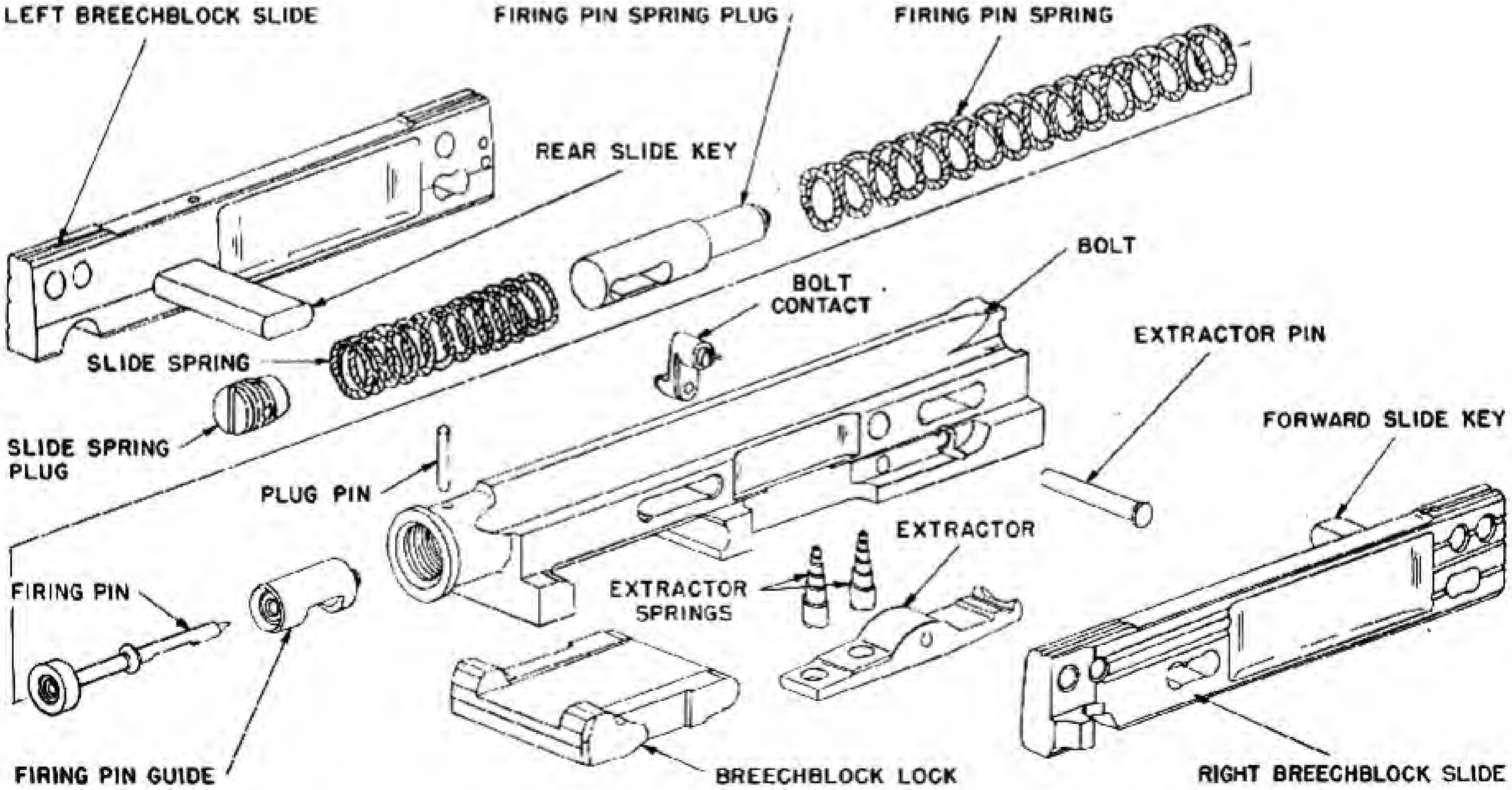
Breech Unlocking, Schematic

extractor. During recoil of the breech block, the cartridge case is ejected downwards by the spring mounted ejector. During the last part of its recoil, the breech block hits against the thrust washer housed in the breech block buffer. Braking is effected by the buffer spring which throws the breech block forward when released. If the trigger lever remains on "firing position," the sear does not engage the breech block and a new cycle begins.

If the trigger is released then the trigger lever frees the sear, which rises and catches the breech block which is checked by the buffer spring. The full engagement of the sear is assured by the sear ramp. On release, the springs of the buffer device return the breech block to its cocked position.


RING SPRING ASSEMBLY
FOLLOWER
FOLLOWER
FRONT RECOIL SPRING SEAT
RECOIL SPRING
REAR RECOIL SPRING SEAT
RECOIL HOUSING

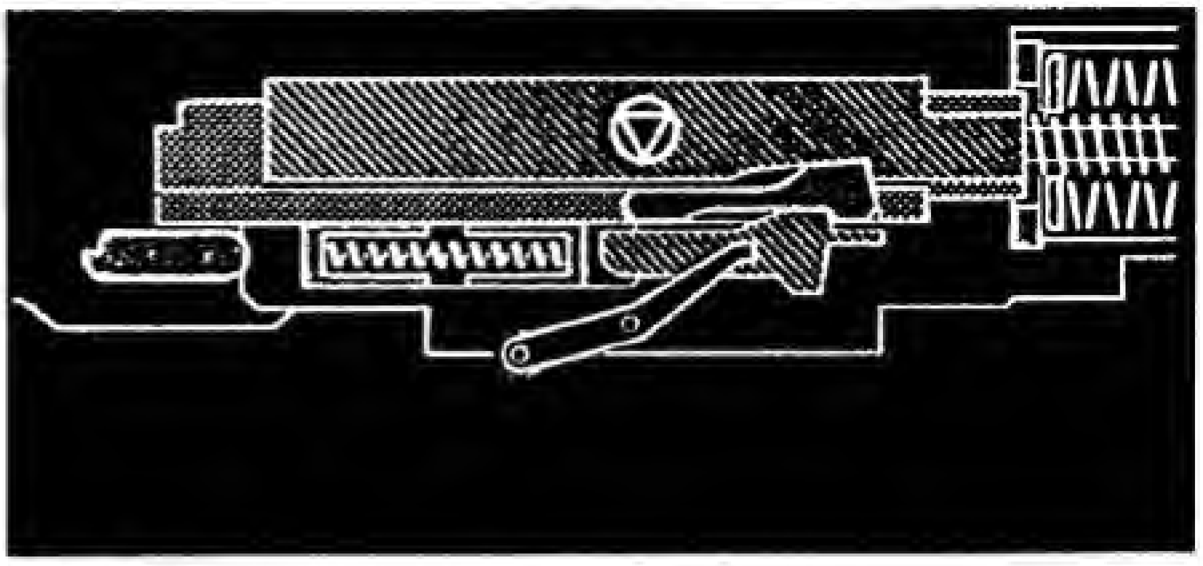
Recoiling Action, Schematic


LEFT BREECHBLOCK SLIDE
FIRING PIN SPRING PLUG
FIRING PIN SPRING
REAR SLIDE KEY
BOLT
BOLT CONTACT
SLIDE SPRING
EXTRACTOR PIN
FORWARD SLIDE KEY
SLIDE SPRING PLUG
PLUG PIN
EXTRACTOR
FIRING PIN
EXTRACTOR SPRINGS
FIRING PIN GUIDE
BREECHBLOCK LOCK
RIGHT BREECHBLOCK SLIDE

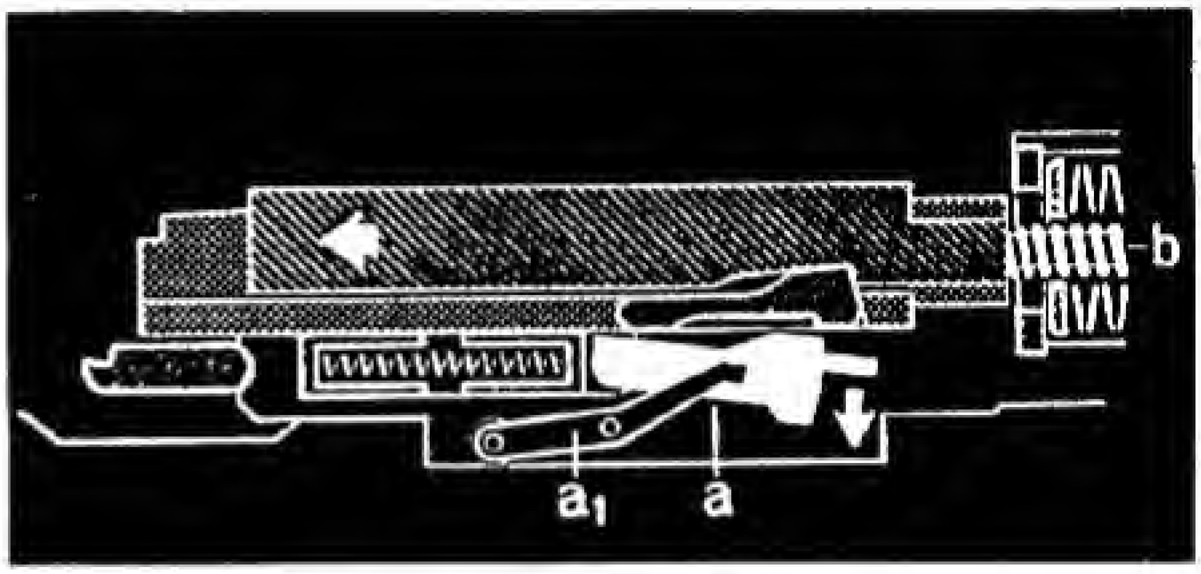
Disassembly of Mk 12 Anti-Aircraft Gun

Functioning of the Weapon

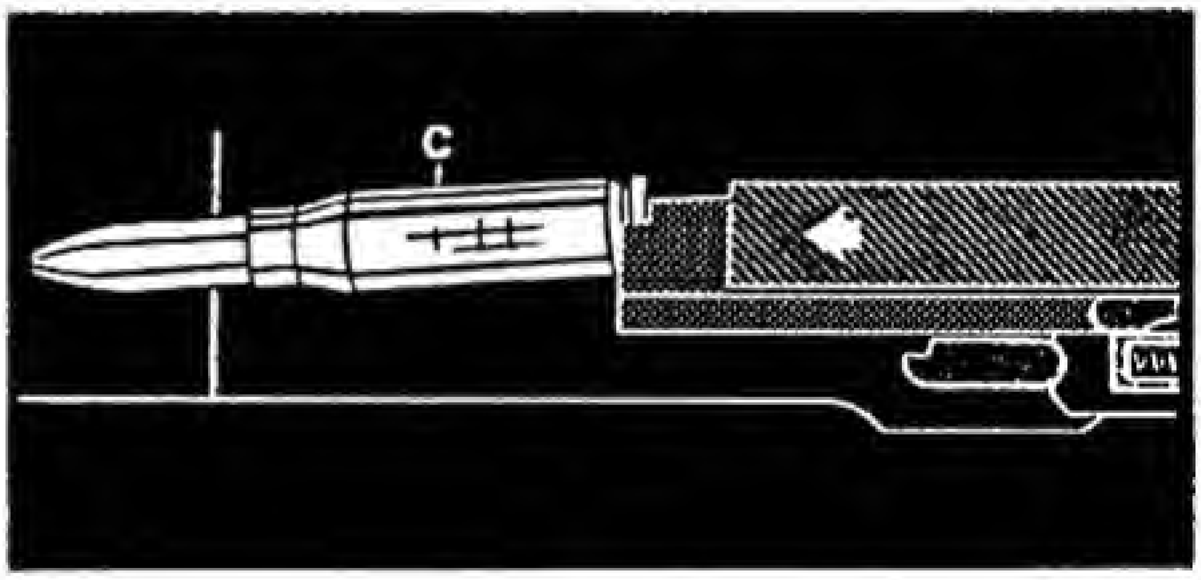
Cocked Weapon. The breech block is open and the driving spring is compressed to the maximum.



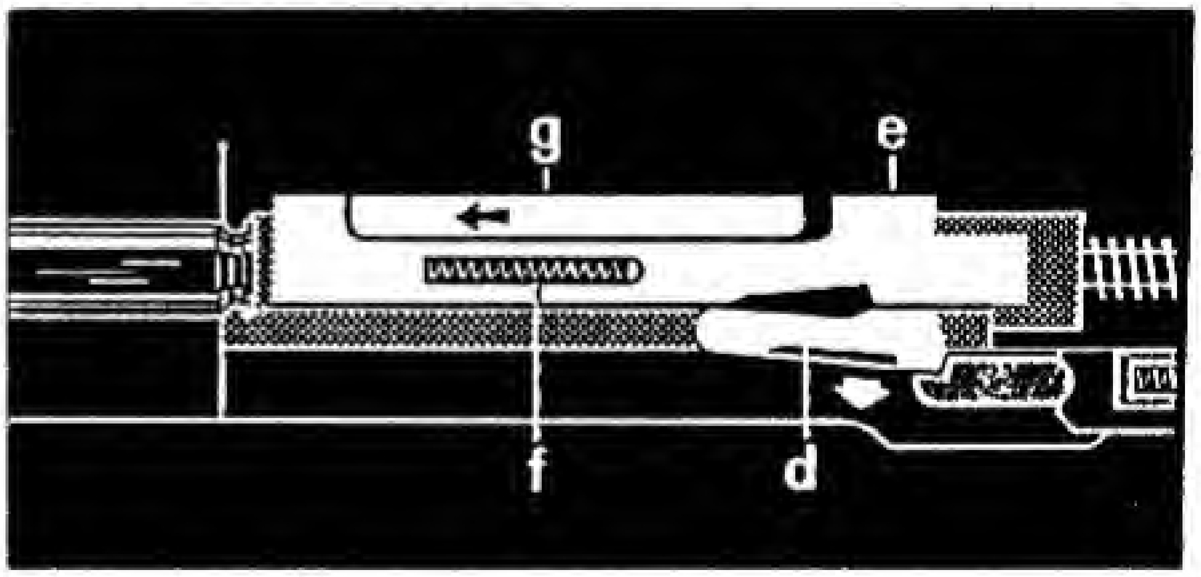
Forwarding of Breech Block. The sear (a) being lowered by the trigger lever (a1) frees the breech block which is thrown forward by the driving spring (b).



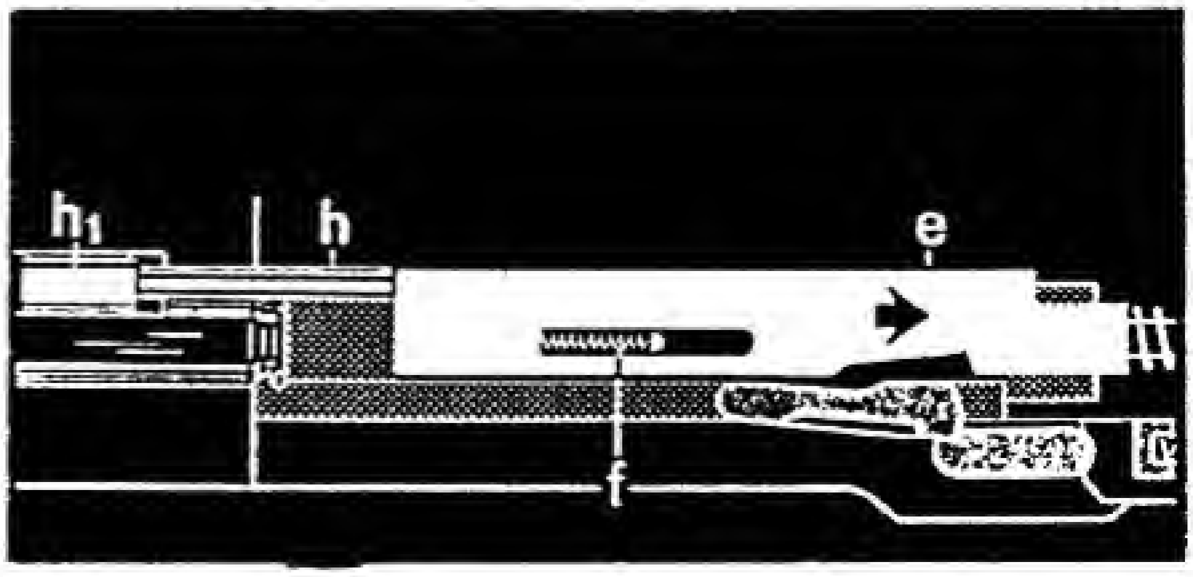
Introduction of the Cartridge. The breech block pushes the cartridge (c) out of the lips of the feed mechanism and inserts it in the cartridge chamber.



Locking and Firing. When the breech block reaches the end of its forward run, the lock (d) moves downwards and frees the bolt slides (e) which ensure, under the action of their springs (f), the locking security of the breech block. (The lock is made fast by the bolt slides equipped with inertia blocks (g) which protect the device against possible premature unlocking.) In this position the propellant charge is ignited.

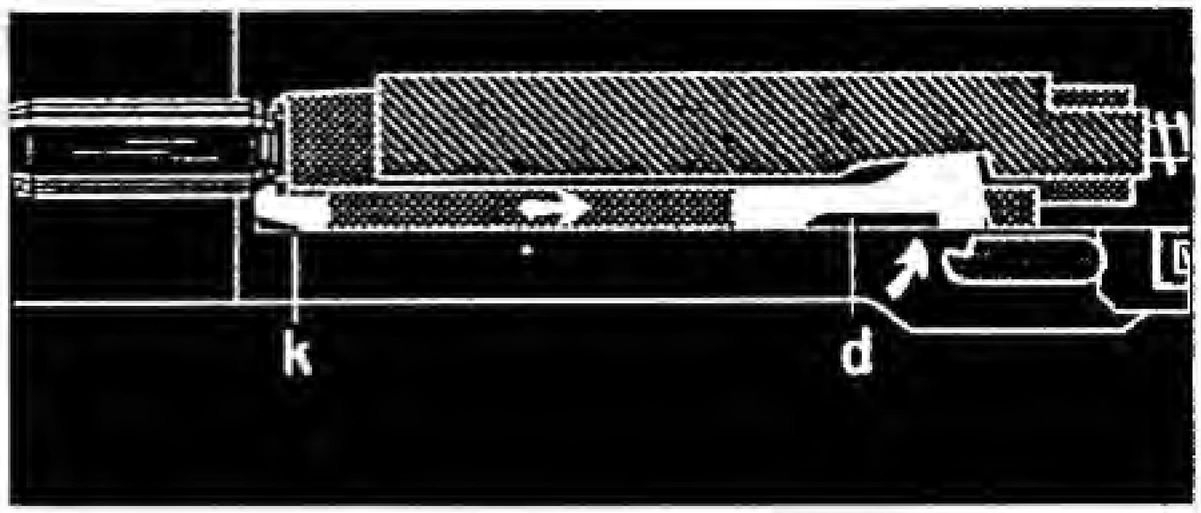


Unlocking. Firing having taken place the whole of the weapon recoils. A gas operated mechanism presses the unlocking pistons (h1) and pushrods (h) backwards. These pushrods cause the bolt slides (e) to recoil and the lock is freed. In this position the bolt slide springs are compressed again.

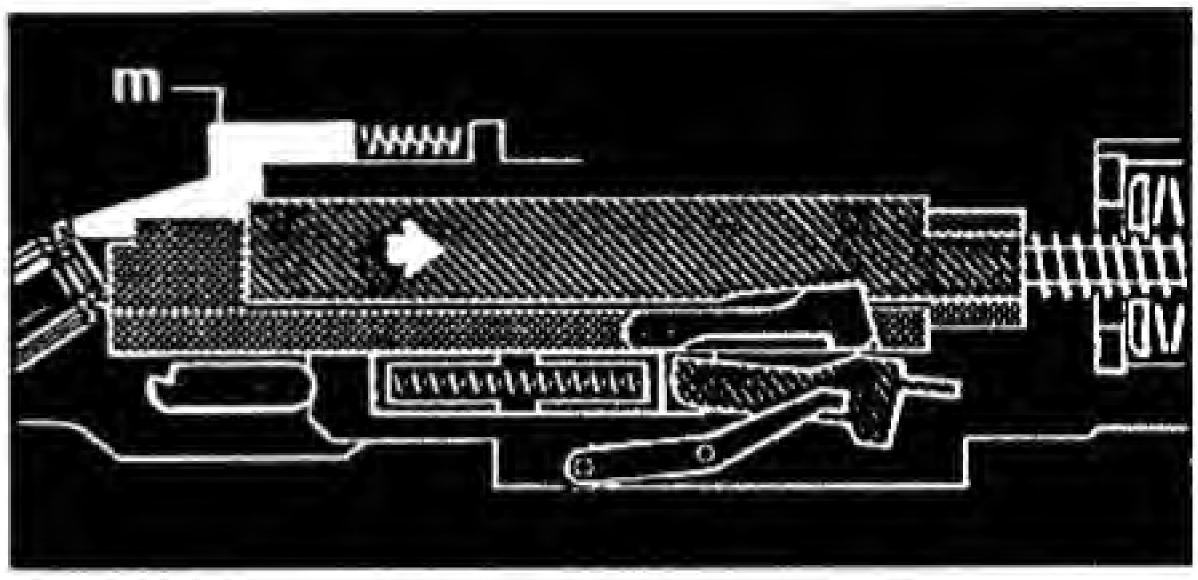


Under the action of the residual gas pressure, the breech block pushes the lock (d) into inert position and starts to recoil.

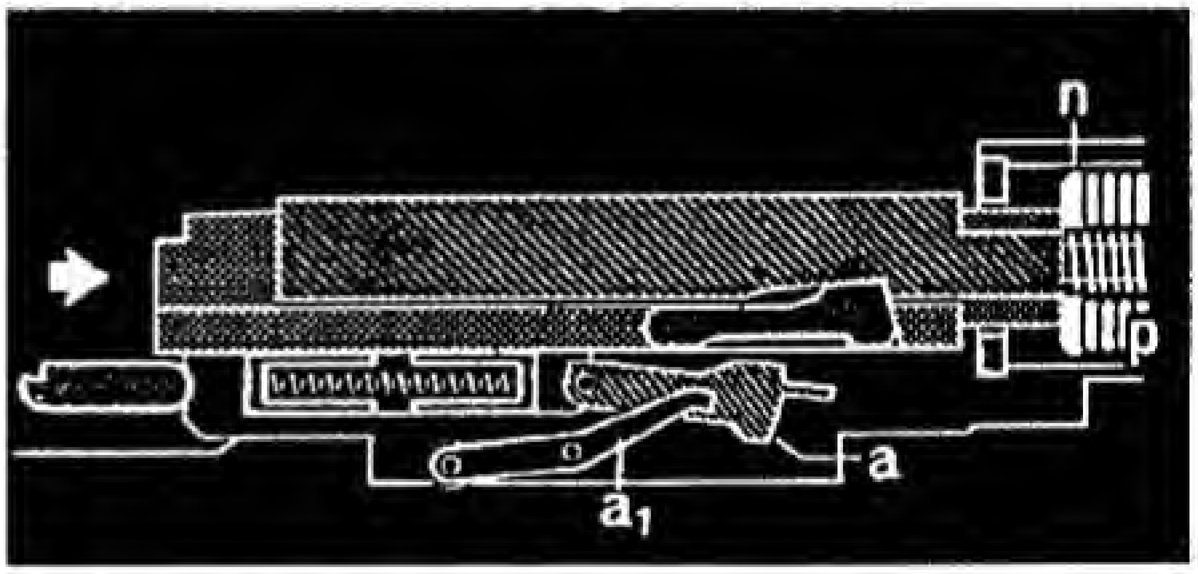
The cartridge case is withdrawn from the cartridge chamber by the extractor (k).



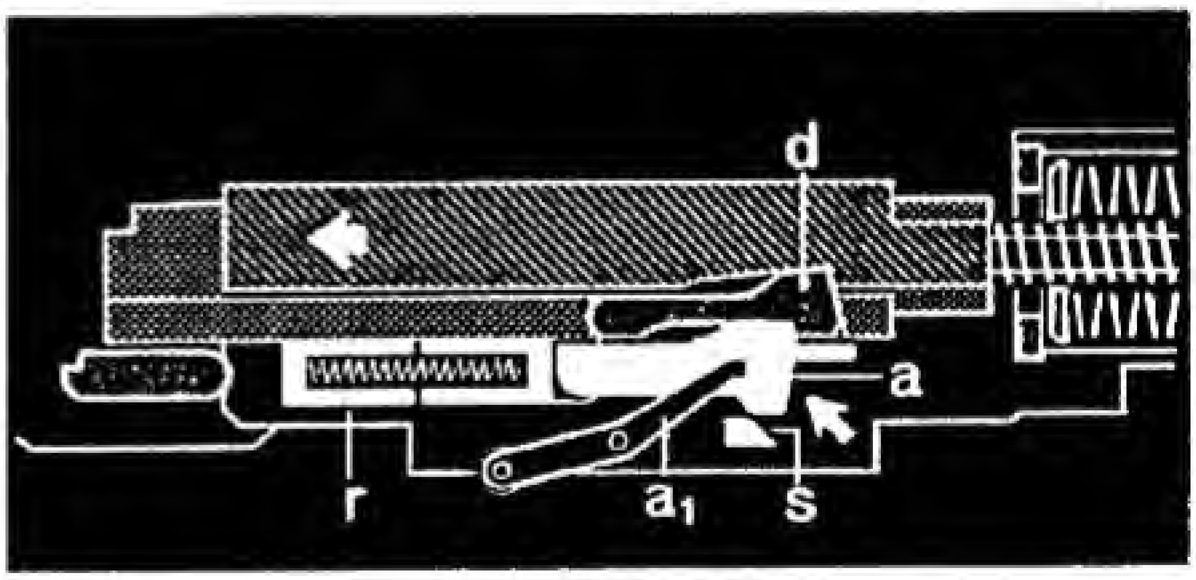
Ejection of the Cartridge Case. During recoil of the breech block, the cartridge case is thrown downwards by the ejector (m) mounted on springs.



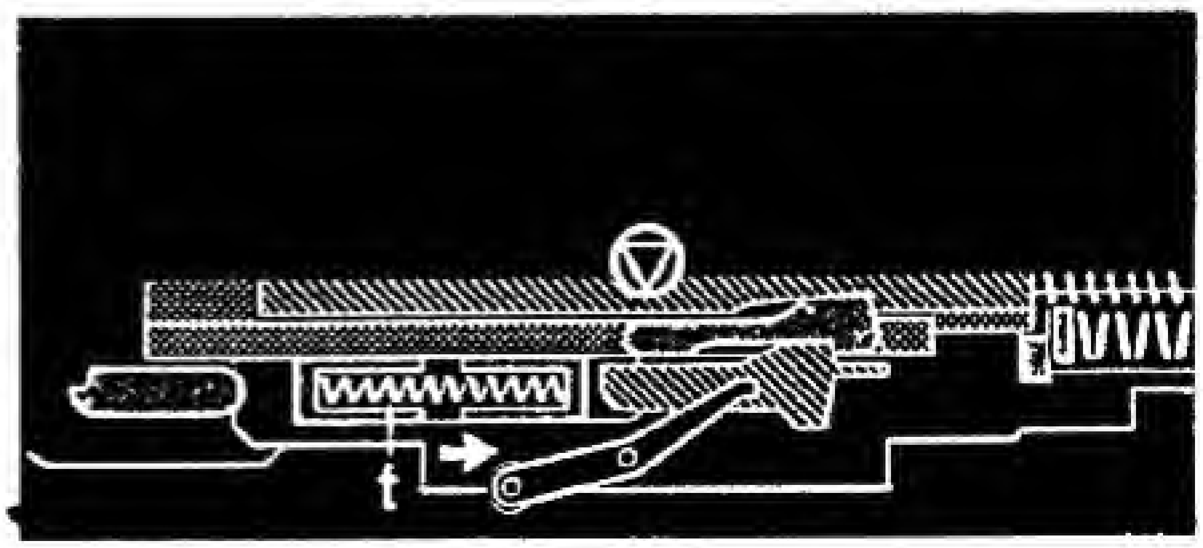
End of Recoil. During the last part of its recoil, the breech block hits against the thrust washer (n) housed in the breech block buffer. Braking is effected by buffer spring (p) which throws the breech block forward when released. If the trigger lever (a1) remains on "firing position," the sear (a) cannot catch the breech block and a new cycle begins (burst).

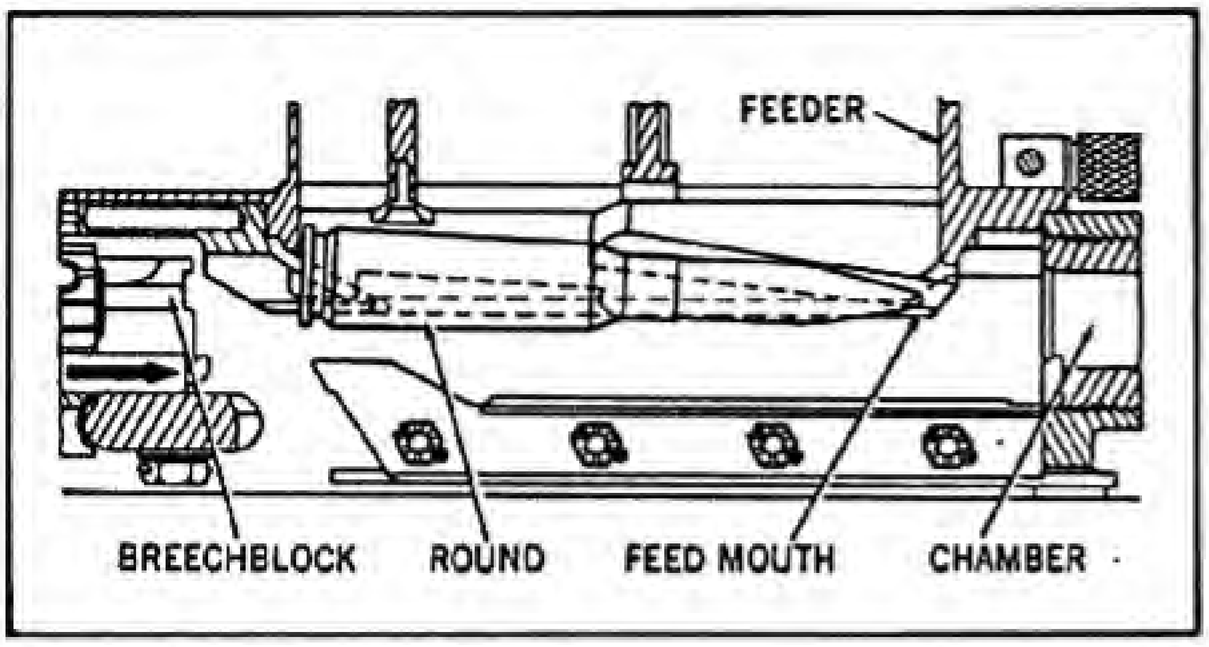


Interception of the Breech Block. (At the last round of a burst or in single round firing.) As soon as the trigger lever (a1) frees the sear, the latter rises and catches the breech block on passing; it is checked by the buffer spring (r). The full engagement of the sear is assured by the sear ramp (a).

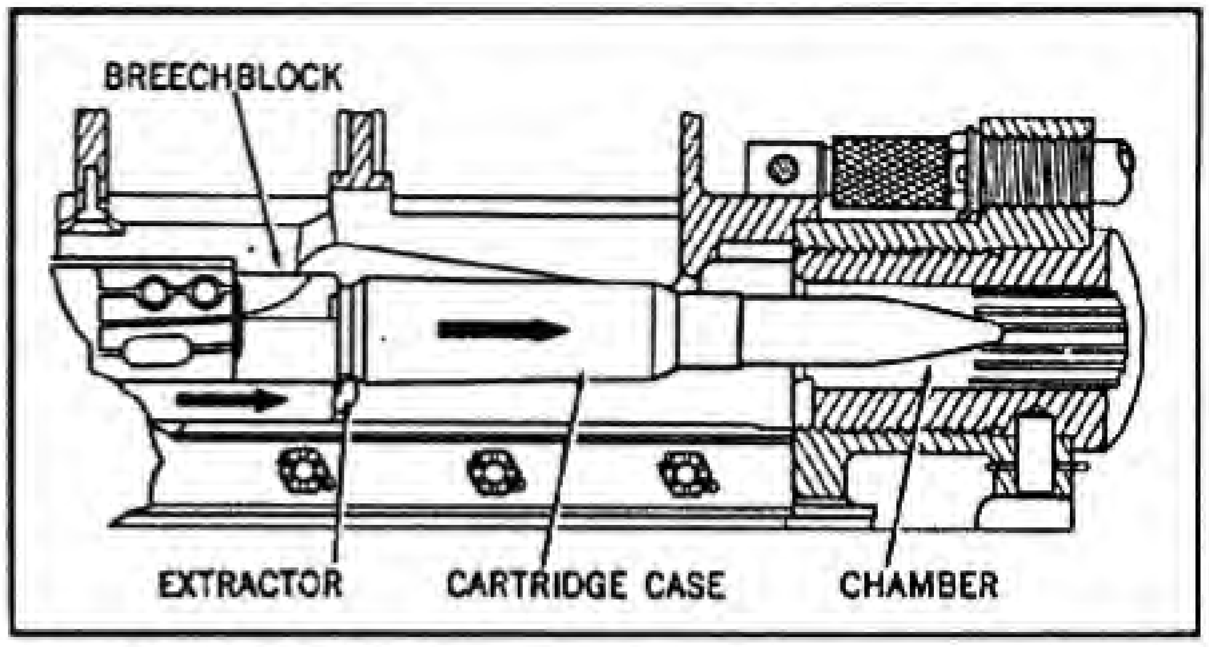


On being released, the springs (t) of the buffer device return the breech block to its cocked position.

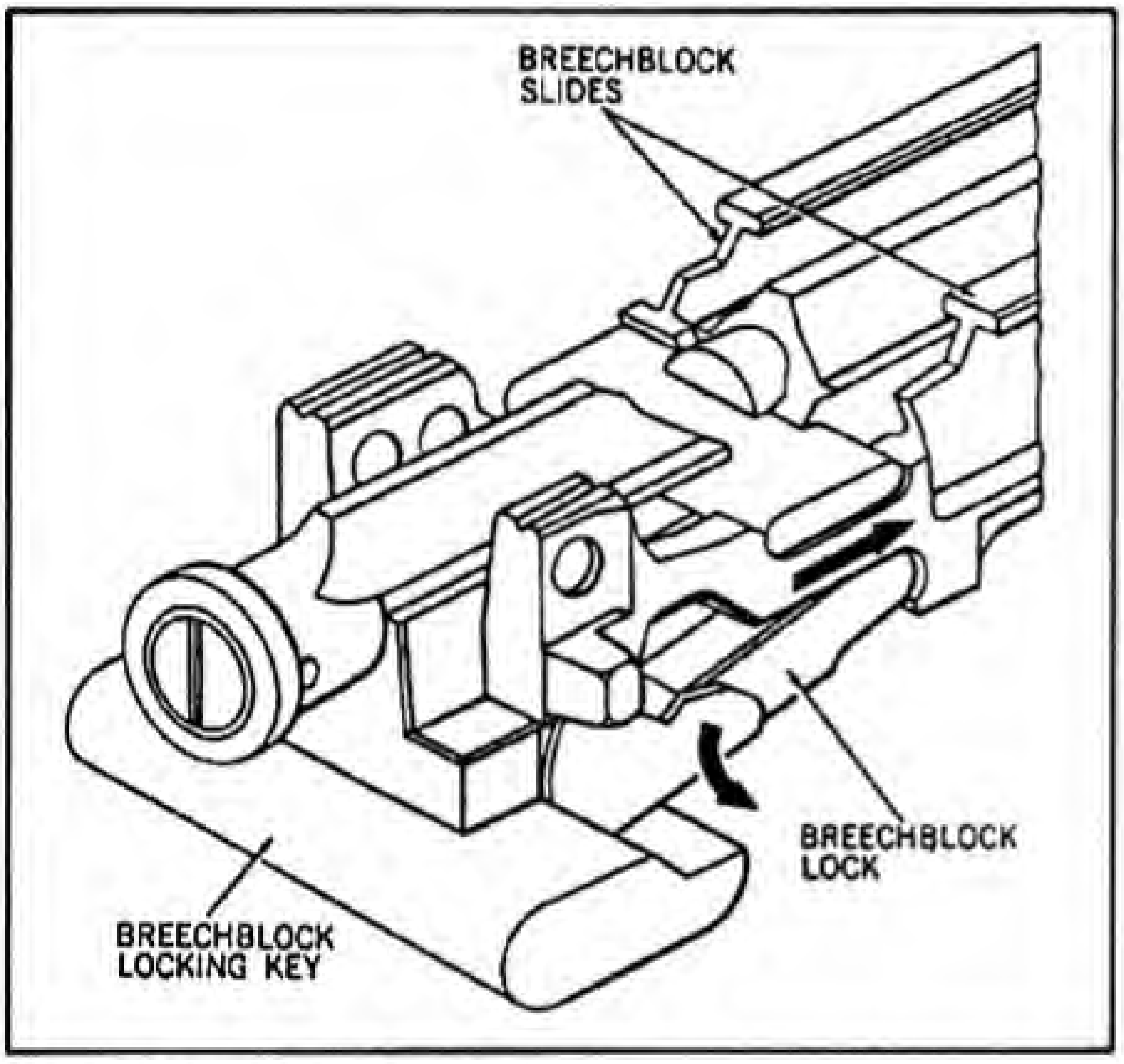



FEEDER
BREECHBLOCK
ROUND
FEED MOUTH
CHAMBER

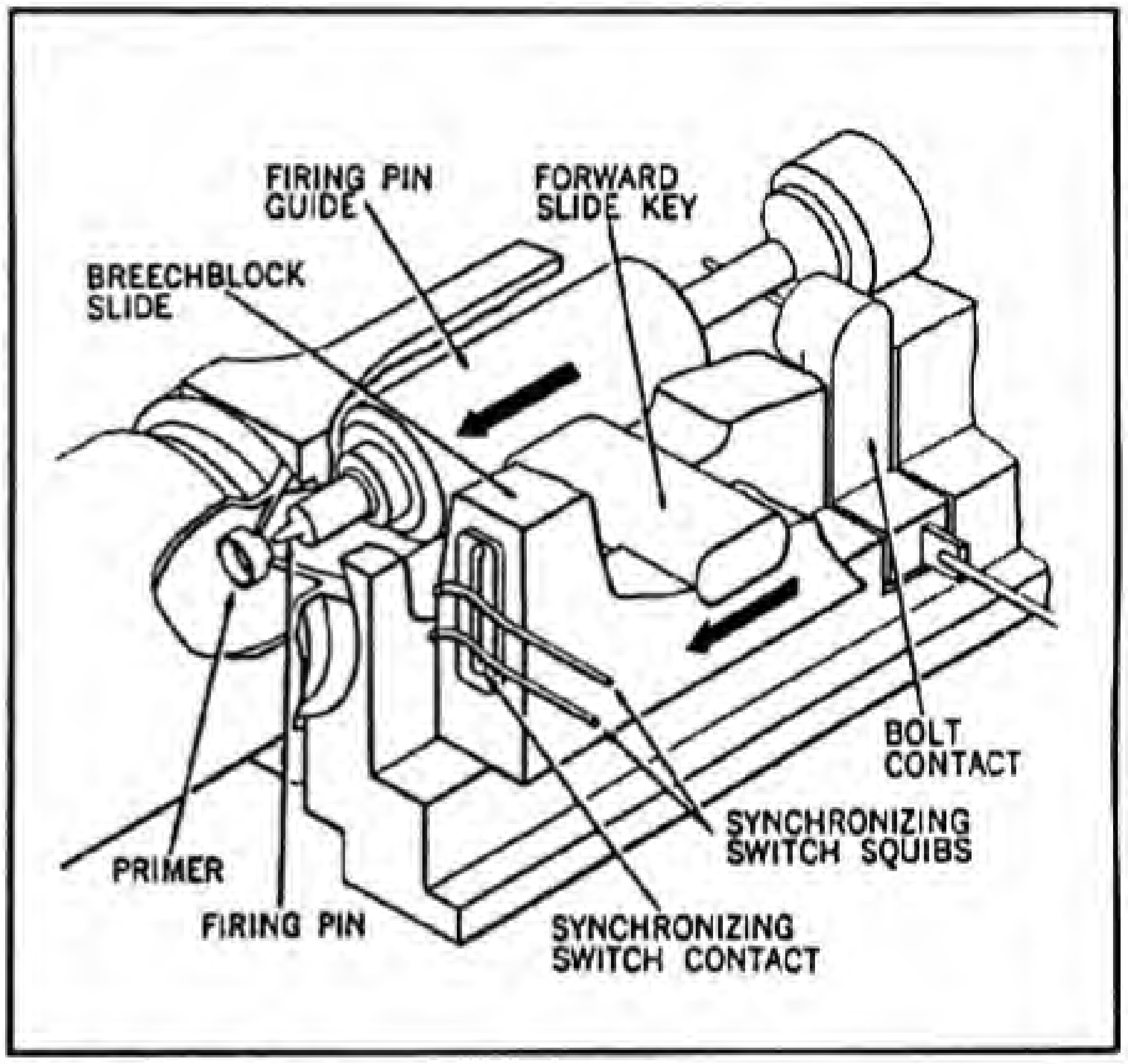
Round Chambering Actions


BREECHBLOCK
EXTRACTOR
CARTRIDGE CASE
CHAMBER

Breech Closing Actions


BREECHBLOCK SLIDES
BREECHBLOCK LOCK
BREECHBLOCK LOCKING KEY

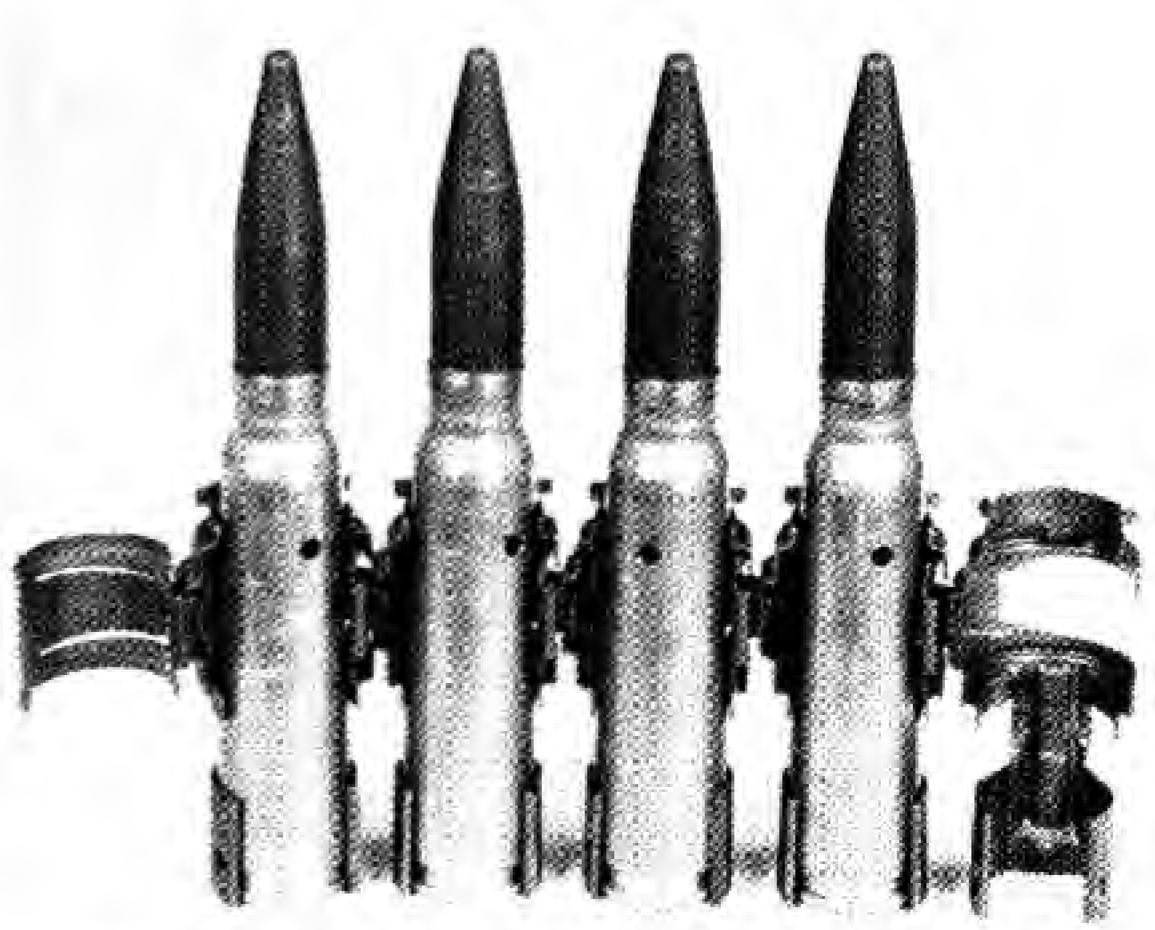
Breechblock Unlocking Actions


FIRING PIN GUIDE
FORWARD SLIDE KEY
BREECHBLOCK SLIDE
BOLT CONTACT
SYNCHRONIZING SWITCH SQUIBS
PRIMER
FIRING PIN
SYNCHRONIZING SWITCH CONTACT

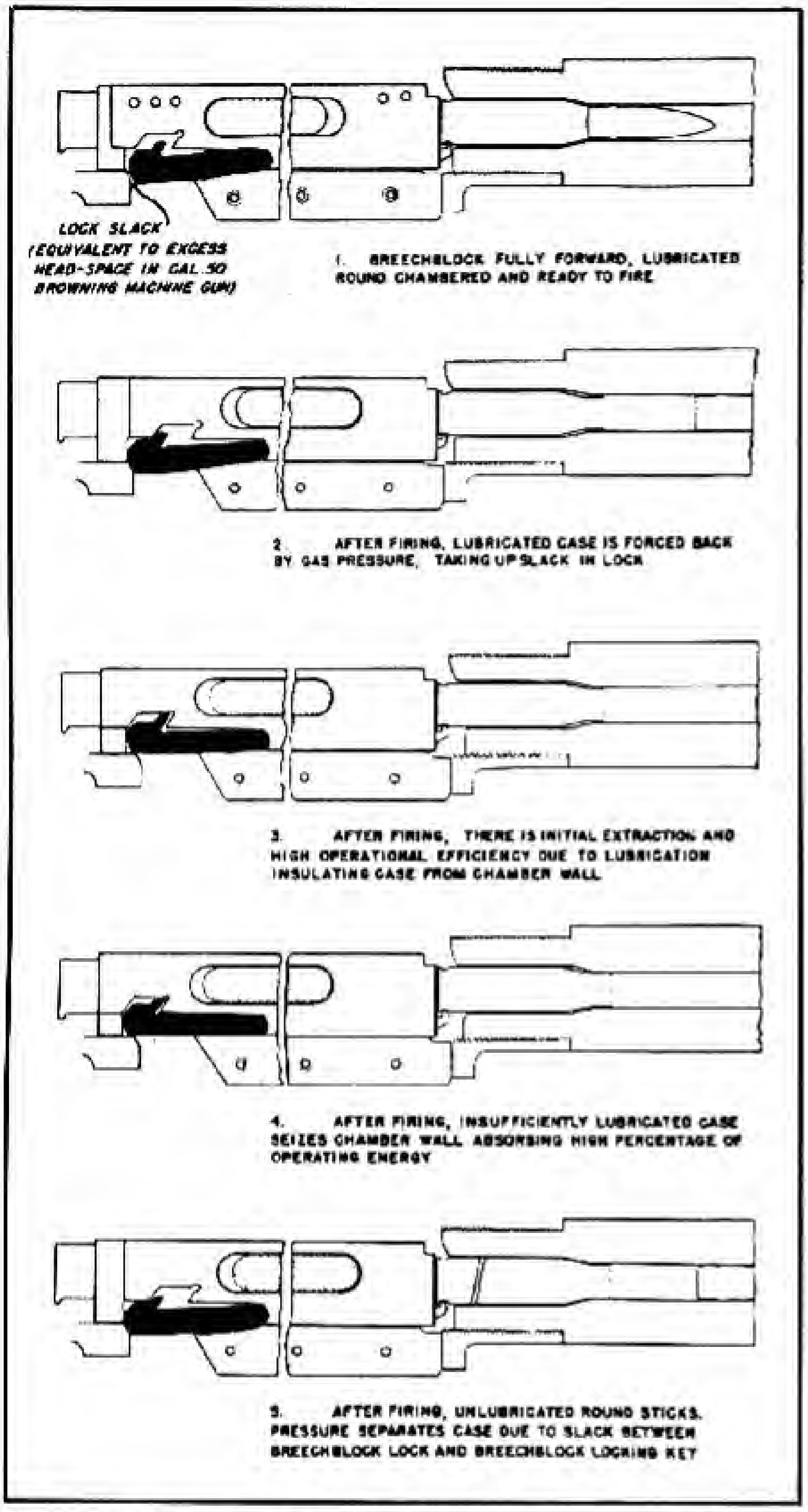
Gun Firing Actions

Ammunition

Ammunition for the 20mm automatic gun is issued in the form of complete rounds of "fixed" ammunition. The term "fixed," used in conjunction with ammunition, signifies the propelling charge is fixed (not adjustable) and that the round is loaded into the gun as a unit. A complete round consists of all the components necessary to fire the weapon once, that is, projectile, cartridge case, propellant and electric primer. The electric primer and propellant is assembled in the cartridge case; the cartridge case is criped rigidly to the projectile. The ammunition authorized for this gun is classified as a high-explosive incendiary, incendiary, armor-piercing with tracer, target-practice, or drill, depending on the type of projectile.



Belt of Ammunition for 20mm Mk 12 Mod 0 Machine Gun


LOCK SLACK
(EQUIVALENT TO EXCESS HEAD-SPACE IN CAL .50 BROWNING MACHINE GUN)

1. BREECHBLOCK FULLY FORWARD, LUBRICATED ROUND CHAMBERED AND READY TO FIRE

2. AFTER FIRING, LUBRICATED CASE IS FORCED BACK BY GAS PRESSURE, TAKING UP SLACK IN LOCK

3. AFTER FIRING, THERE IS INITIAL EXTRACTION AND HIGH OPERATIONAL EFFICIENCY DUE TO LUBRICATION INSULATING CASE FROM CHAMBER WALL

4. AFTER FIRING, INSUFFICIENTLY LUBRICATED CASE SEIZES CHAMBER WALL ABSORBING HIGH PERCENTAGE OF OPERATING ENERGY

5. AFTER FIRING, UNLUBRICATED ROUND STICKS. PRESSURE SEPARATES CASE DUE TO SLACK BETWEEN BREECHBLOCK LOCK AND BREECHBLOCK LOCKING KEY

Serious Malfunction Occurs if Ammunition is not Lubricated.

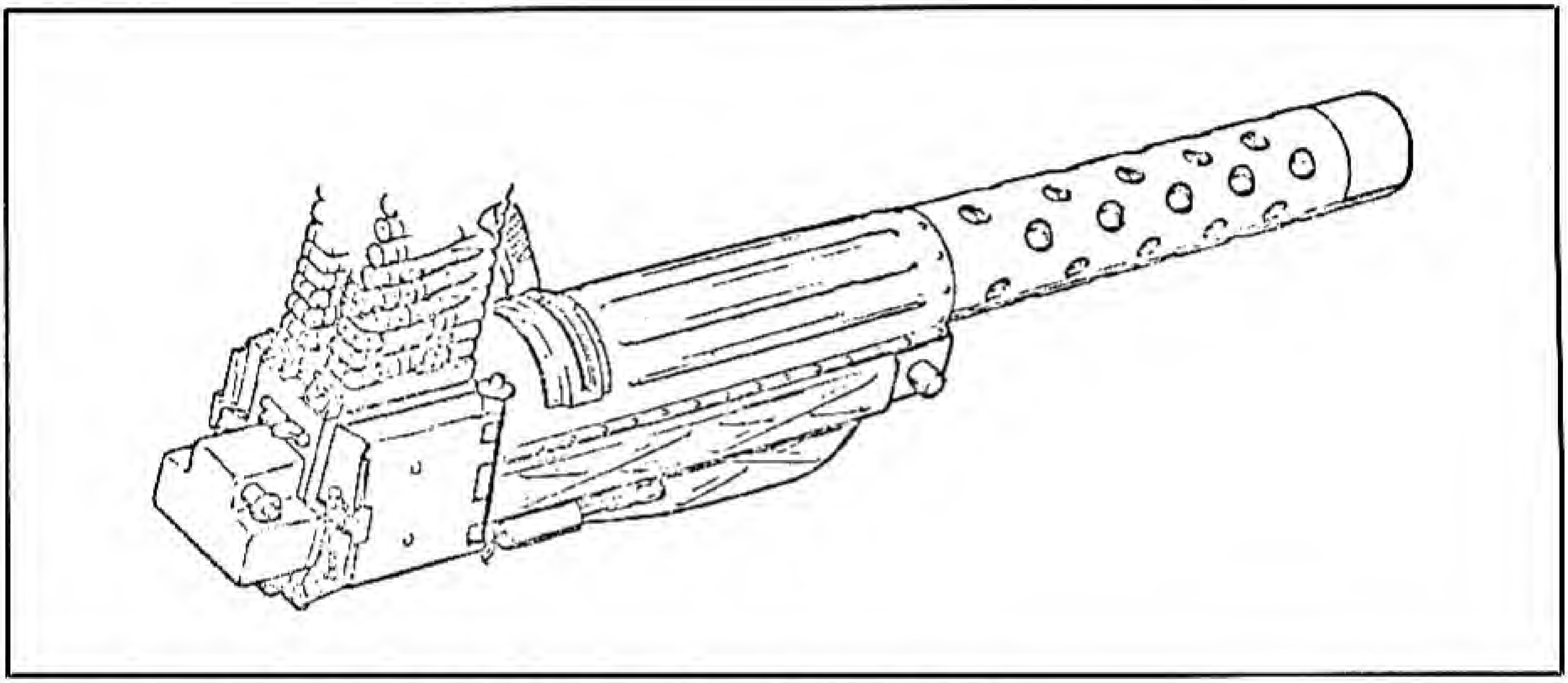
Characteristics of the Ammunition

Muzzle Velocity of Projectile	3543 fps
Practical Range of Projectile	9844 ft.
Weight of Cartridge	.870 g
Weight of Projectile	.360 g
Weight of Explosive Incendiary Charge, Type UIA	42 g

Chapter 40

7.62mm ADVANCED ARMORED VEHICLE MACHINE GUN

PHILCO-FORD CORPORATION



7.62mm Advanced Armored Vehicle Machine Gun - Concept Feasibility Model

History

On August 20, 1971, the Philco-Ford Corporation completed a 15 month program to deliver an operating test model for an Advanced Armored Vehicle Machine Gun to the United States Army Weapons Command at Rock Island. This work was based on a company sponsored program begun in 1969, the aim of which was to develop a replacement for the M73 machine gun. In addition to the usual types of modifications made during the development tests, the original design as submitted in 1969 underwent significant evolutionary changes.

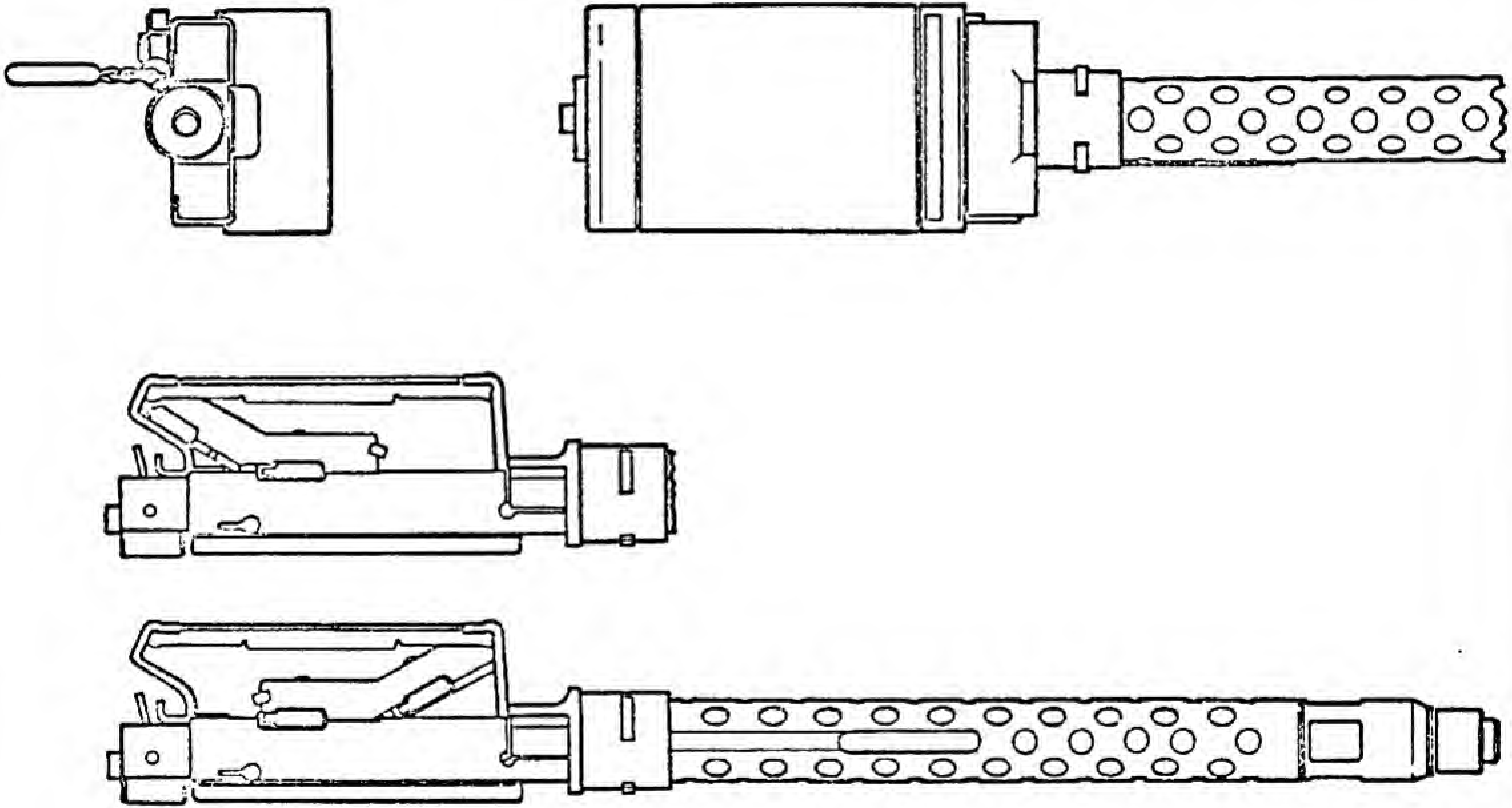
According to the final report, only one firing fixture was constructed along with one concept Feasibility Model.

Description and Purpose

The Philco-Ford Advanced Armored Vehicle Machine Gun is an air cooled, recoil operated, fully automatic machine gun featuring dual selective belt fed with continuous control of bolt motion.

The weapon fires standard 7.62mm ammunition. Its design characteristics include short recoil operation, mechanically linked barrel and bolt, dual selective belt feed with first round response, quick change barrel with two spare barrels carried within the gun, no operator handling of hot barrels, 450 to 600 rounds per minute firing rates depending upon muzzle booster, wide range of mount compatibility, multi-lug rotary bolt locking, and fixed head space.

The purpose of the weapon was to provide an



Self-Powered Weapon Concept

Characteristics

Bore Size	7.62mm
Muzzle Velocity	2700 fps
Rate of Fire	450-600 rpm
Basic System of Operation	Short Recoil
Locking System	Rotating Bolt
Power Source Feed System	Recoil
Feed System	Cam Operated
Type of Feed (location)	Link (top, dual, selective)
Method of Chambering	Ram
Type of Accelerator	Lever
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	Private
Manufacturer	Philco-Ford
Developer	Philco-Ford
Utilization	Vehicle
Ammunition Type	7.62 x 51 NATO
Removal	Quick change stroke 2.875 in.
Type of Firing Mechanism (firing pin)	Percussion
Method of Cooling	Air
Type of Breech Mechanism	Manual

armored vehicle machine gun with the same general dimensions as the M73 and utilizing a mechanically linked bolt and barrel.

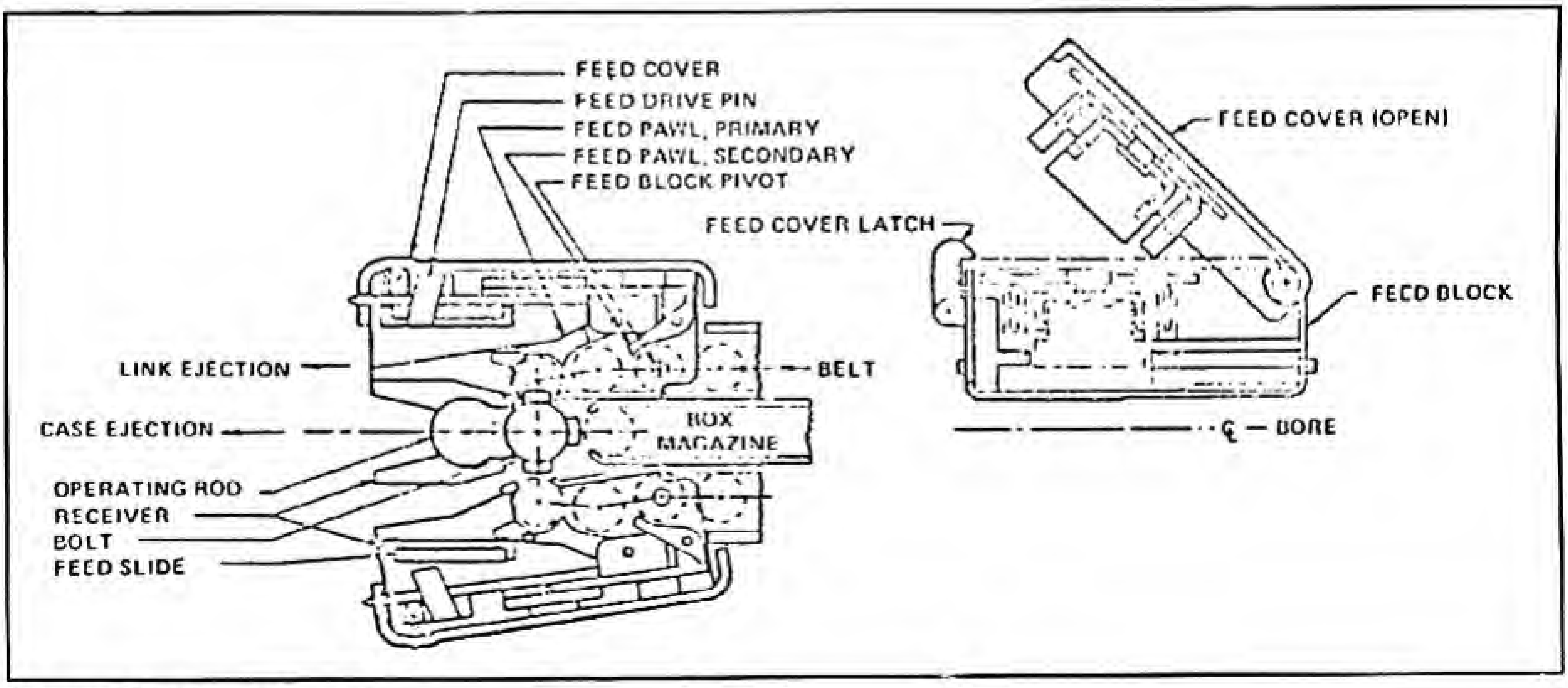
Cycle of Operation

The following cycle of operation is for the firing fixture.

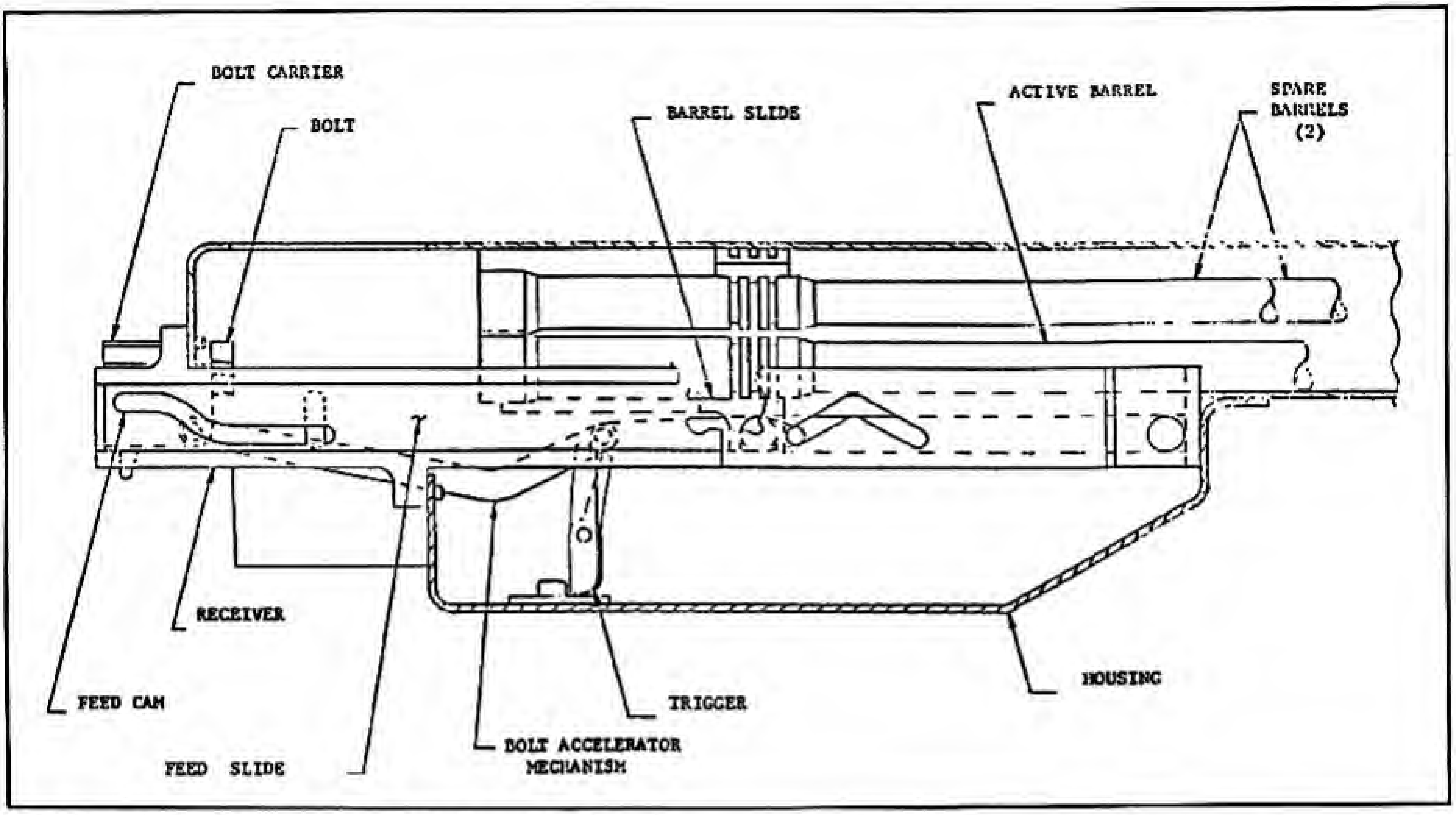
To fire the weapon, remove the safety pin and pull the operating rod (trigger bar) to the rear. Initial movement of the operating rod removes the obstruction which had previously blocked sear motion. Continued movement of the operating rod causes the barrel sear to rotate inward, thereby releasing the feed slide along with the rest of the recoiling parts (barrel, barrel slide, crank and bolt carrier assemblies) which are then driven forward under the action of the drive springs.

As the recoiling parts start to move forward, the crank assembly, which is still in the dwell portion of the operating cam, causes the bolt carrier group to move forward with the barrel group. As the bolt moves past the feed group, a locking lug on the bolt contacts the base of the round in the feed station and strips the round out of the linked belt. At this point the main operating cam begins to act upon the cam follower of the crank. This camming action rotates the crank and accelerates the bolt carrier towards the barrel. As stripping of the round nears completion, the cam in the feed slide begins to act on the drive pin of the pawl assembly. During the forward (counter-recoil) movement, the pawls advance the ammunition belt one-half pitch and the feed pawl is retracted to a position where it picks up the next round.

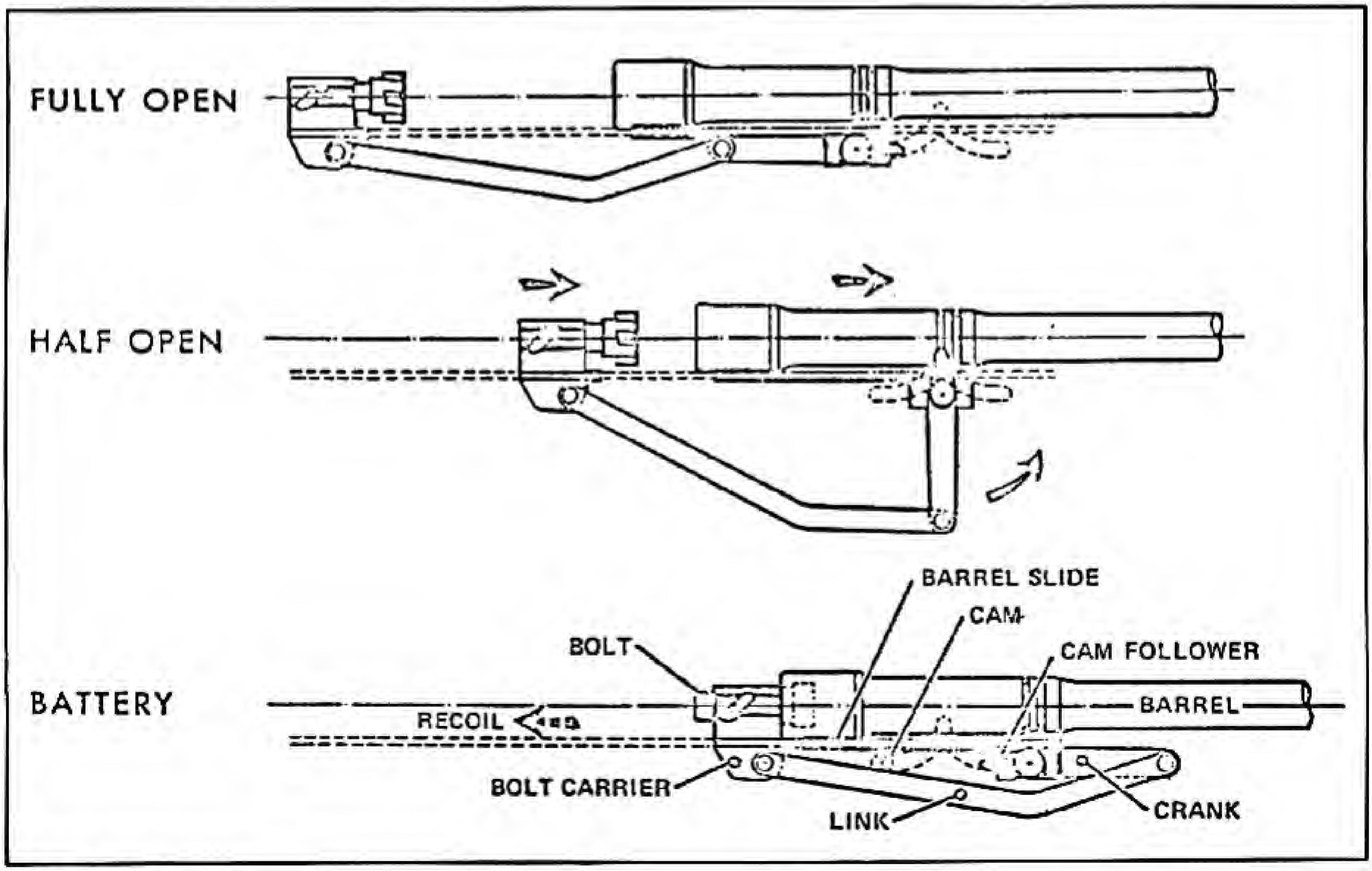
After the crank cam follower passes through the top center position in the main operating cam, the crank assembly begins to decelerate the bolt carrier. During the last motions of the bolt carrier as it closes against the barrel assembly, the bolt is inserted into



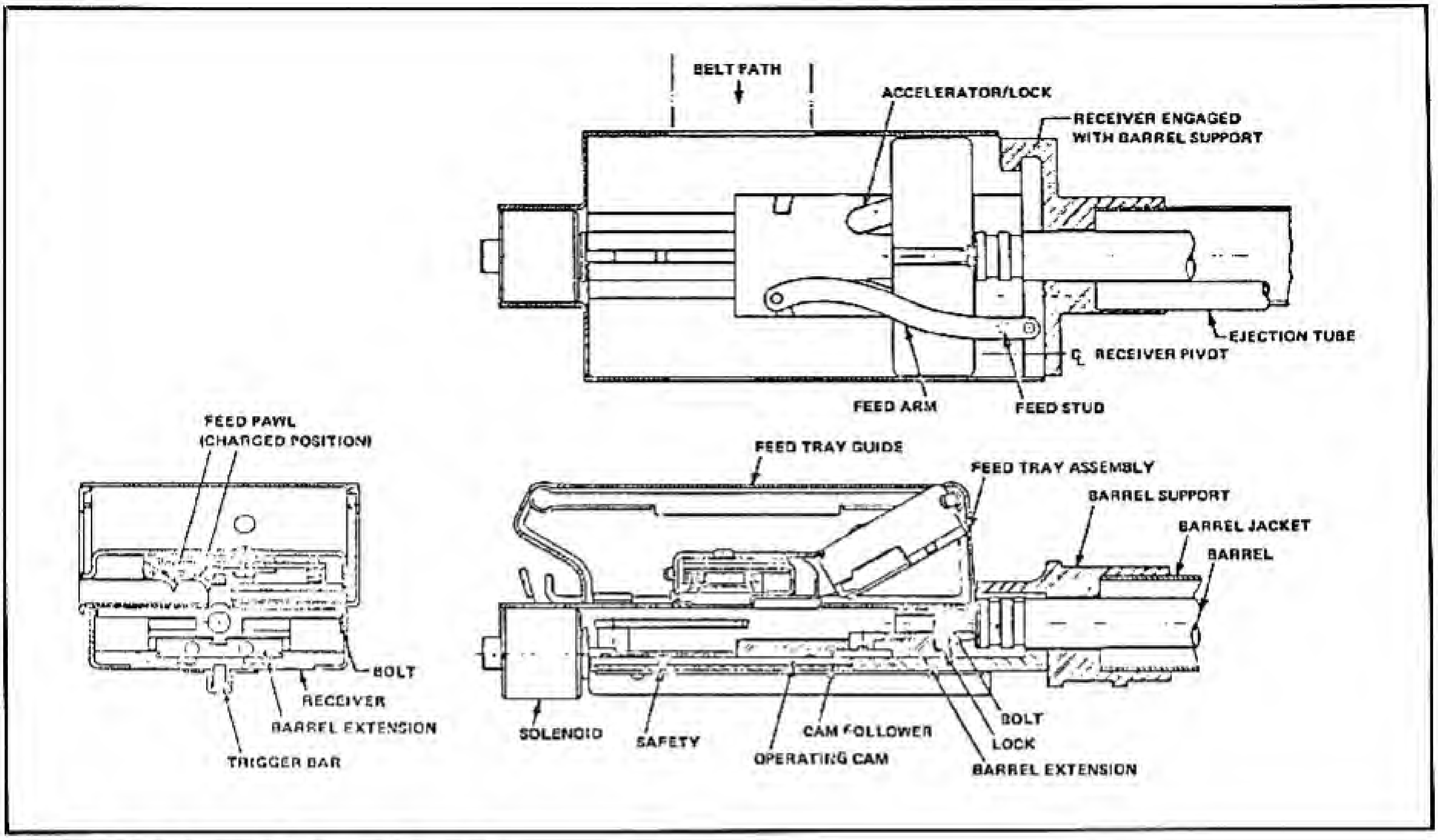
Selective Multi-Feed Concept


BOLT CARRIER
BOLT
BARREL SLIDE
ACTIVE BARREL
SPARE BARRELS (2)
RECEIVER
FEED CAM
TRIGGER
HOUSING
BOLT ACCELERATOR MECHANISM
FEED SLIDE

Advanced Armor Machine Gun - Bolt Open - Full Recoil


FULLY OPEN
HALF OPEN
BATTERY
BARREL SLIDE
CAM
BOLT
CAM FOLLOWER
BARREL
RECOIL
BOLT CARRIER
LINK
CRANK

Basic Action Sequence


BELT PATH
ACCELERATOR/LOCK
RECEIVER ENGAGED WITH BARREL SUPPORT
EJECTION TUBE
℄ RECEIVER PIVOT
FEED ARM
FEED STUD
FEED PAWL (CHARGED POSITION)
BOLT
RECEIVER
BARREL EXTENSION
TRIGGER BAR
FEED TRAY GUIDE
FEED TRAY ASSEMBLY
BARREL SUPPORT
BARREL JACKET
BARREL
SOLENOID
SAFETY
CAM FOLLOWER
OPERATING CAM
BOLT
LOCK
BARREL EXTENSION

Section of Self-Powered Weapon Concept

the locking recesses and locked in place. Prior to insertion of the bolt into the barrel extension locking recess, the cam pin which connects the bolt and bolt carrier is lying in a dwell portion of the cam in the bolt carrier; thus there is no torque applied to the bolt throughout most of its forward stroke. However, as the bolt begins to enter the barrel assembly, the helical flanks of the bolt locking lugs meet the helical surfaces of the lug passages in the barrel assembly which causes the bolt to rotate a small amount and to bring the cam pin into the active portion of the locking cam in the bolt carrier. The final movement of the bolt carrier as it closes against the barrel assembly causes the cam to complete bolt rotation, locking the bolt in place. The small helix lead on the fore and aft locking surfaces can be used to provide cartridge case crush-up as desired. The entire recoiling parts then move forward as a unit until the trailing end of the hammer sear (pivoted in the bolt carrier) strikes an abutment on the barrel sear, which releases the hammer and fires the round.

When the round fires, the impulse reverses the barrel motion and drives the recoiling parts to the rear, compressing the drive springs and reversing the crank rotation as it passes through the cam. The crank rotation, acting through the link, accelerates the bolt carrier away from the barrel completing the cycle of operation.

Test Results

Live test firing of the weapon began in March 1971, with the objective of firing 25 round bursts from each of the two feed groups with NATO Code A127 ammunition as well as to evaluate the operation of the test fixture.

According to the final report many modifications were made to the test fixture. However, with three exceptions, the problems encountered during testing were found to be routine to the development of new and untried concepts, and easily corrected by minor modifications. The three exceptions were the dynamic firing mechanism, the spring ejector mechanism, and the high frictional losses present. Each of these problems required significant effort to effect a solution.

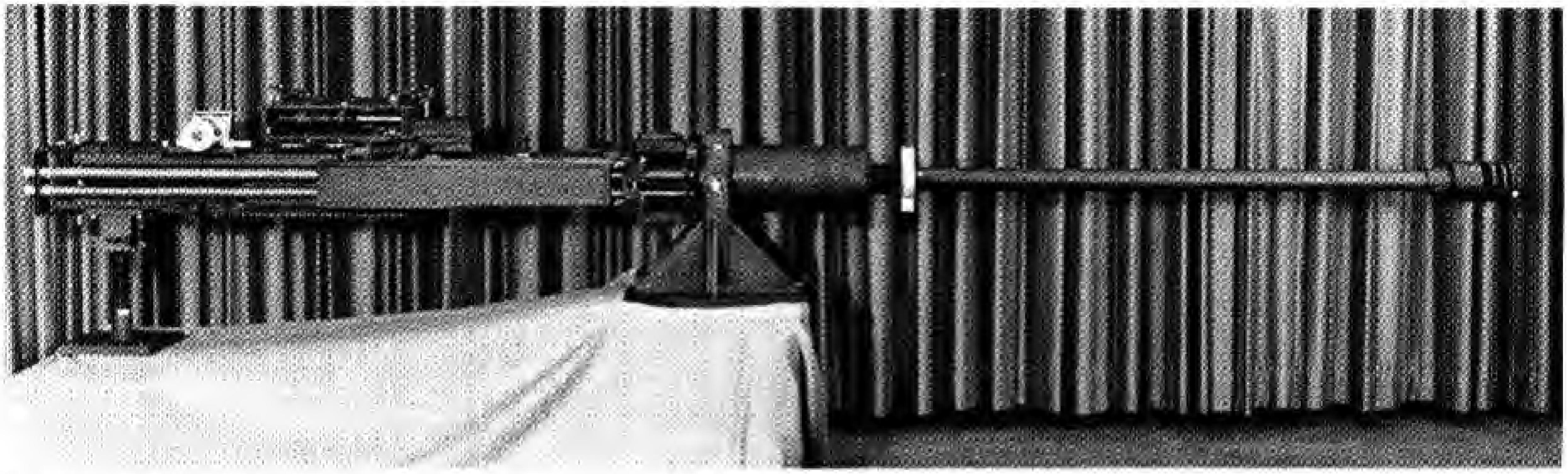
A spring-hammer firing mechanism resolved the ignition problems. A fixed ejector assembly, a widened crank assembly, widened receiver clearances and an enlarged ejection port solved the ejection problem. The high frictional losses in the mechanism were mostly overcome after many small interferences were identified and eliminated, all sliding surfaces were lapped and polished, stiffer drive springs were installed and a front barrel support and muzzle booster assembly were added.

Studies based on the testing show that the Philco-Ford Advanced Armored Vehicle Machine Gun is sensitive to impulse, spring energy, recoiling mass and elevation angle but appears to be insensitive to friction variations and belt pulls. It requires at least 2.1 lb/sec of impulse to operate the gun at zero elevation with nominal friction and driving springs used in this analysis. There is also a limited driving spring range over which the gun will operate satisfactorily. The current driving spring design of 62.5 lb/sec energy appears to be reasonable for an effective ammunition impulse level of 2.7 lb/sec or less.

Chapter 41

30mm ROTARY GUN

GENERAL ELECTRIC



General Electric Single Barrel Rotary Gun

History

Work began on this very interesting firing mechanism in June 1973. The original purpose was to provide General Electric with a competitor to the Hughes Chain Gun. When the EX-28 failed to meet its requirements, part of the settlement was that G.E. would provide two self-powered rotary guns to the Navy. The gun in 1973 was still in the prototype stage. The gun has been burst fired.

Description and Purpose

The name Rotary Gun is very misleading. The self-powered version of the Rotary Gun is a recoil operated, rotating bolt locked, single barrel air cooled weapon. "Rotary" refers to the feeder.

The basic concept is to utilize the energy of the recoiling barrel and convert the linear motion into rotary motion through the use of cams.

The weapon is 117 inches long and 11.5 inches in both height and width. The barrel is 89 inches long. The gun weighs 300 pounds without the charger. Charging is with an electro-mechanical device.

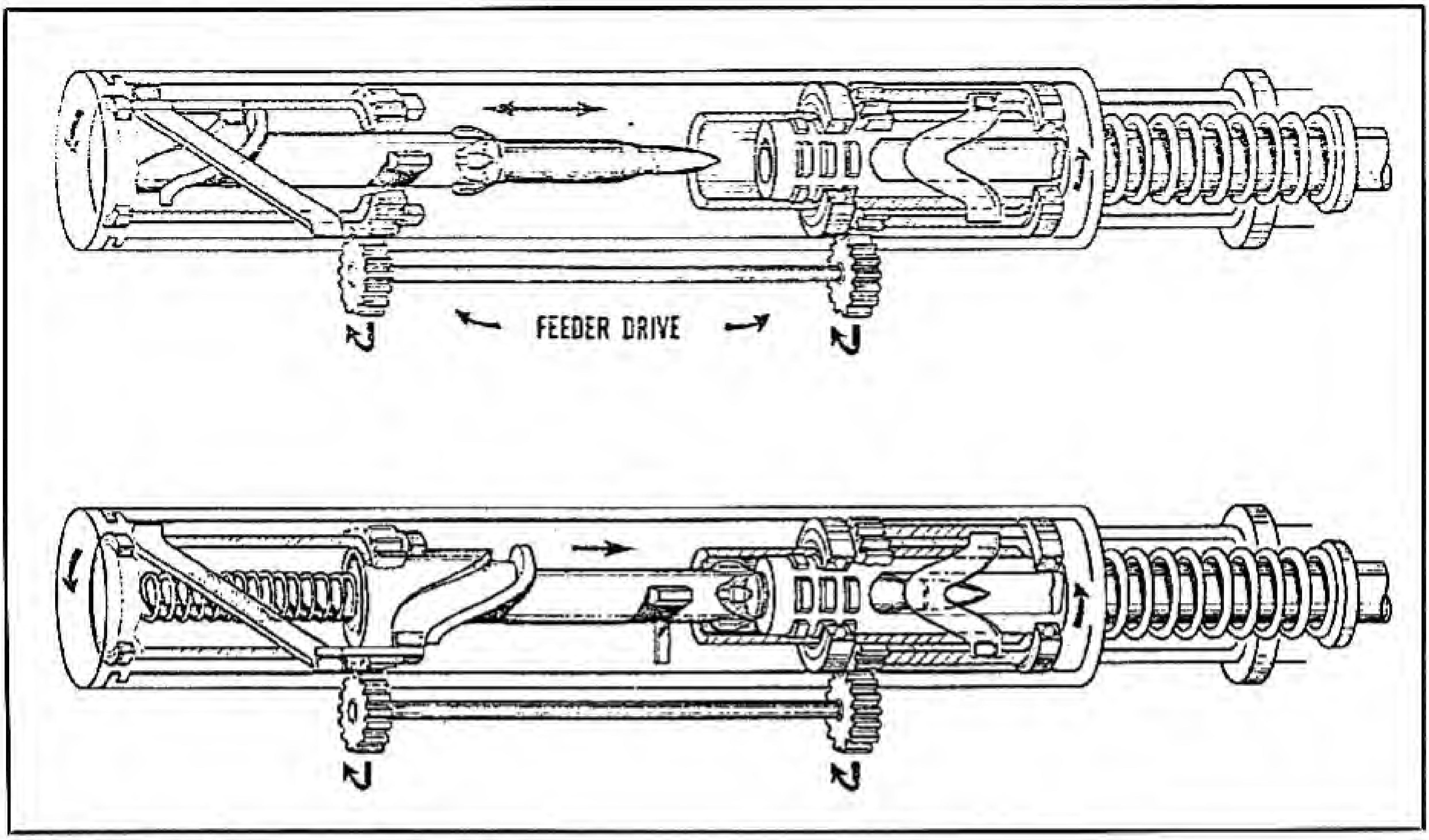
Cycle of Operation

The barrel recoil is converted to rotary motion of a forward rotor through rotary cams in the barrel extension. The rotary motion of the forward rotor is transferred to an aft rotor which drives a cam engaged with a fixed cam in the gun housing and a translating cam in the bolt carriage. The bolt and the barrel extension are positively controlled throughout the gun cycle by the angular orientation of the rotors. The energy transfer from the recoiling barrel to the gun mechanism occurs over a longer time span than in conventional recoil-operated mechanisms.

Combination Feeder. A unique feeder was designed specifically for the Rotary Gun. It offered either single feed or dual feed. In the dual feed mode, either of two types of ammunition could instantaneously be selected to be the next firing round.

Test Results

The weapon underwent development testing by G.E. Problems in controlling the heavy GAU-8 round were encountered.



Major Components

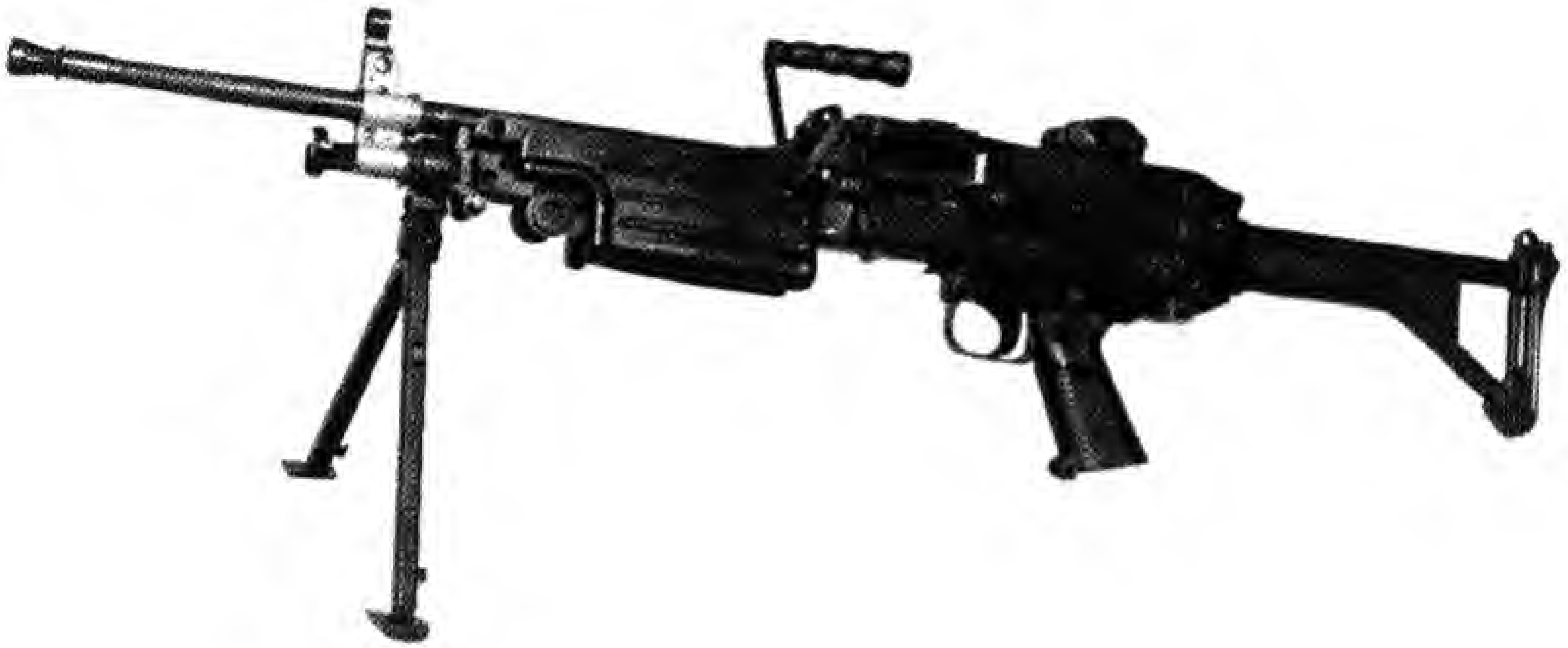
Characteristics

Bore Size	30mm
Muzzle Velocity	3250–3350 fps
Rate of Fire	300/600 spm
Basic System of Operation	Ext. or Self Pwr. (Elec/Recoil)
Method of Charging	Electro-Mechanical Device
Manufacturer	General Electric
Ammunition	GAU-8 or Wecom 30
Overall:	
Length	117 in.
Width	11.5 in.
Height	11.5 in.
Weight	300 lbs. without charger

Chapter 42

5.56mm M249 (MINIMI) SQUAD AUTOMATIC WEAPON

FABRIQUE NATIONALE



5.56mm M249 Squad Automatic Weapon

History

The new 5.56mm M249 SAW, light support weapon was developed by Fabrique Nationale of Belgium to meet the requirements expressed by NATO (North Atlantic Treaty Organization) and by the USA (S.A.W. program).

The M249, known in Europe as the FN MINIMI was first unveiled in 1974. The design assures high functioning reliability through the use of a time tested gas piston system.

The weapon is reliable, useful, needed, suited to filling a very real present gap in our arsenal, excellent for its purpose, and should give the opposition fits in the field by providing the U.S. Squad and Fire Team with a high volume of sustained fully-automatic fire for suppression of enemy fire and maneuver.

The industrial production of this weapon started in 1980 and mass production at the end of 1981.

In February 1982, the M249 was incorporated into the U.S. Army's basic equipment range. A first order, including 13,200 weapons and 16 million cartridges, were placed with us in September 1982.

In order to meet modern battle conditions, Fabrique Nationale decided to develop a complete weapon and ammunition system designed to increase troop effectiveness and interoperability.

They believed that only a firm having an extensive experience of the design and manufacture of wea-

Characteristics

Calibre	5.56mm
Weight:	
Weapon with bipod	15.10 lb.
Barrel, complete with flash hider, gas regulator and sights	3.46 lb.
Bipod	1.08 lb.
Sling	1.34 lb.
Box for 200 cartridges (empty)	0.50 lb.
Box for 200 cartridges (full)	6.98 lb.
FN 30 round magazine (empty)	0.50 lb.
FN 30 round magazine (full)	1.32 lb.
US M16 type magazine (empty)	0.25 lb.
US M16 type magazine (full)	1.08 lb.
Dimensions:	
Overall Length	40.87 in.
Barrel, without extension nor flash hider	18.35 in.
Rifled length of barrel	16.69 in.
Line of sight	19.49 in.
Rifling:	
—6 grooves right	
—Twist: 12" for SS92 and M193 (U.S.) ammunition	
7" for SS 109 ammunition and other NATO-approved ammunition.	
Overall Height:	
Bipod open (low position)	13.98 in.
Bipod open (middle position)	16.54 in.
Bipod open (high position)	18.31 in.
Bipod folded	10.63 in.
Width:	
Bipod open (low position)	12.60 in.
Bipod open (middle position)	14.96 in.
Bipod open (high position)	17.32 in.
Rate of Fire:	
Cyclic	700 to 1,000 rpm
Effective	500 rpm in 5′ (with barrel change)

pons and ammunition could develop such a system.

Fabrique Nationale, the only privately-owned company making and designing both the weapons and corresponding ammunition, developed a system comprising three advanced products, namely:

—the FNC carbine
—the M249MI light support weapon
—the NATO ammunition

Description

The FNC is a gas operated weapon. It is fitted with a positive locking system: the rotative bolt locks directly into the barrel extension.

With its butt folded the FNC standard version has the same dimensions as those of the "Bull Pup" type weapons presently available on the market. The short barrel version, however, is 10 cm shorter than such weapons.

The M249 is a true machine gun of reduced weight and size. Its effective range lies between 800 and 1,200 m. It fires belt-fitted ammunition and has a quick-change barrel. The fact that this light machine gun may also be fed with the individual weapon 30 round magazine should the need arise, constitutes undeniable progress from the tactical and logistic points of view.

The Minimi, through its low weight and great fire power, can be used by one man to protect the infantrymen's movements. The infantrymen can thus carry out an assault without being slowed down by a machine gunner equipped with too heavy a weapon.

One of the main characteristics of a combat support weapon is its capability of sustaining high rates of fire. In order to achieve this, the machine gun must:

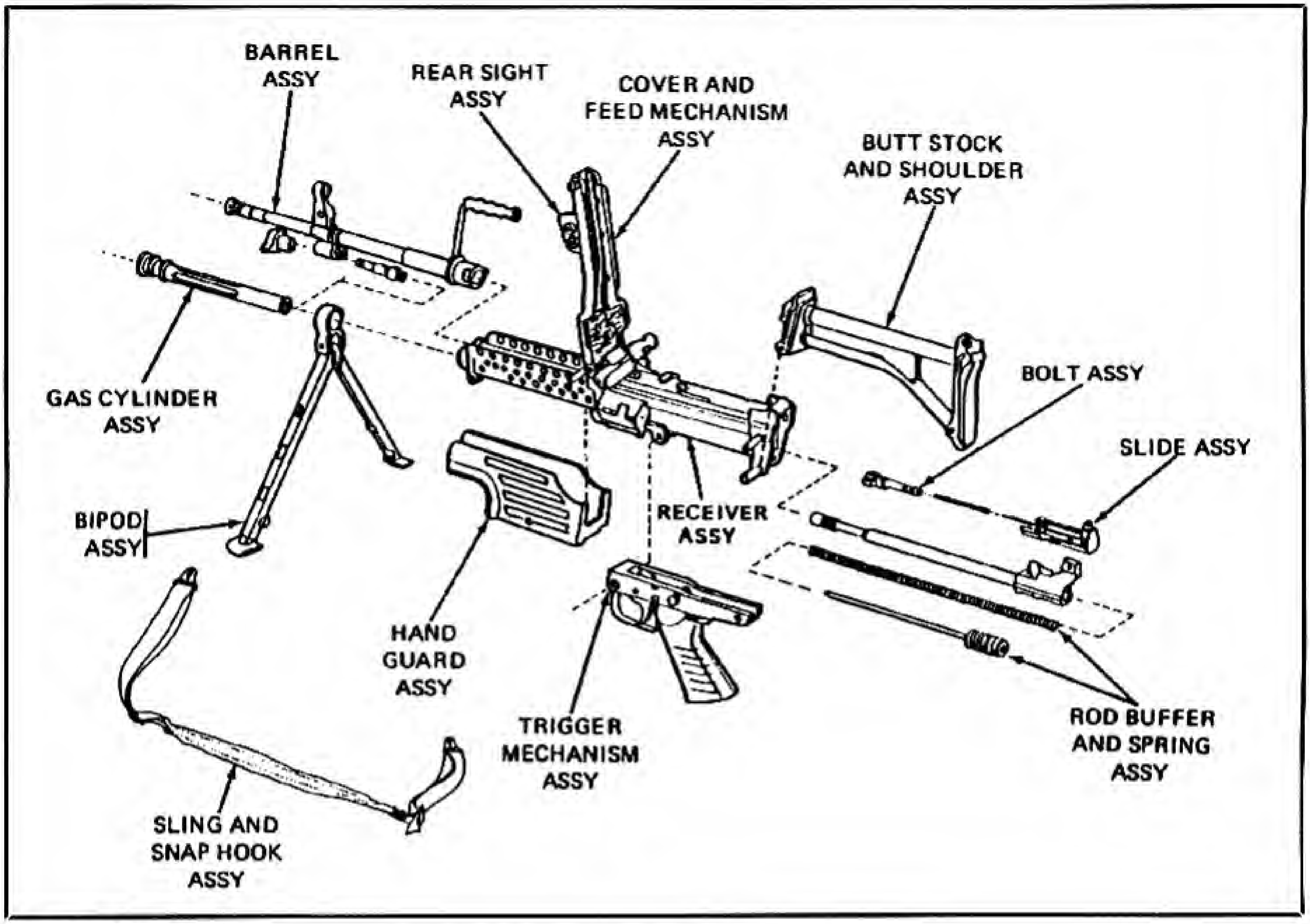
—possess a "quick change" barrel,
—be belt fed,
—fire with an open breech to avoid the "cook-off" phenomenon.

To sustain such high firing rates, the Minimi operates with an open breech cycle, a procedure which prevents the remaining of any cartridge in the chamber.

At the same time, this type of cycle considerably increases cooling by allowing air to circulate through the barrel and significantly delays the onset of "cook-off" (i.e. spontaneous firing of ammunition due to excessive overheating) which frequently happens in closed breech systems.

The Minimi is provided with an "Anti-Run-Away" notch in the sear. This notch will hold the mechanism if the recoil is not sufficient to reach the normal notch. Thus, Run Away, a typical machine gun fault, is not possible with the Minimi. (Run Away: takes place when the moving mechanism components do not move far enough to the rear to be caught by the sear.) In such a case, they will move forward again due to return spring pressure and give rise to an uncontrolled burst of fire.

This machine gun may be fed by a conventional disintegrating link belt which can be housed in a plastic box holding 200 rounds (thus avoiding having to drag a long, hanging belt around). The use of these


BARREL ASSY
REAR SIGHT ASSY
COVER AND FEED MECHANISM ASSY
BUTT STOCK AND SHOULDER ASSY
BOLT ASSY
SLIDE ASSY
GAS CYLINDER ASSY
BIPOD ASSY
RECEIVER ASSY
HAND GUARD ASSY
TRIGGER MECHANISM ASSY
ROD BUFFER AND SPRING ASSY
SLING AND SNAP HOOK ASSY

M249 Field Stripped

boxes is particularly recommended for an assault or an approach march.

As a comparison, a solider armed with the Minimi and a box of 200 rounds carries the same weight as one equipped with a heavy barrel automatic rifle of the FALO type provided with three magazines of NATO 7.62 ammunition (60 rounds).

If we put a 30 round FNC magazine onto the Minimi, we obtain the same fire-power as a BREN, which is exactly twice as heavy to carry.

Equipped with a box containing 200 cartridges, the Minimi still weighs 5½ lbs. less than a NATO 7.62 calibre M60 machine gun without its ammunition.

Cycle of Operation

The weapon is a conventional machine gun with open breech gas-blowback operation, utilizing gases bled from the forward part of the barrel. The rotary gas regulator is a new and simplified design, based on that of the MAG, and has three positions corresponding to normal, emergency (fire under adverse conditions), and grenade launching (anti-tank and anti-personnel). Its position is easily identified by eye or by hand however the barrel may be.

The barrel is locked in position by a cam and can be removed and replaced with one hand, by means of the integral carrying handle.

The return spring is notable for the fact that its buffer is mounted in series, and is thus aligned to its rear.

The breech locking mechanism is of a new FN design, in which the bolt, or breech block, is locked into the barrel extension with a rotational movement induced by a cam in the bolt carrier, thus reducing the forces exerted on the receiver to a minimum. The bolt carrier, or slide, is directly linked to the gas piston below it (as in the MAG), so that the two move together, and it is supported on two longitudinal guide rails. The latter also ensure alignment with the barrel.

Initial recoil, under gas pressure, thus involves only the gas piston and bolt carrier, leaving the bolt itself locked in position until the cam on the bolt carrier comes into play. This permits a regular, progressive fall in residual pressure and a near-total evacuation of gases from the empty cartridge case. When the cam effect begins to unlock the bolt, pressure is practically nil and it is impossible for the spent cartridge case to adhere to the wall of the chamber. Only on completion of the rotational unlocking of the bolt (which has not yet moved rearwards) does primary extraction begin, with a progressive withdrawal of the empty case.

This system of delayed extraction, and the longitudinal guide rails for the working parts, are the most important technical innovations incorporated in the design of the Minimi.

Test Results

A subsequent extensive Operational Test of the M249 was held at Ft. Benning, Ga. The results reinforced the SAW trial conclusions. The M249's performance was so superlative that the Army decided there was no need for the normal follow-on test. The only remaining critical OT issue was the hit capability of the M249. To address this, the Marines, using a platoon of their own operators, conducted exhaustive hit-probability experiments at Aberdeen Proving Grounds, Maryland.

The results far exceeded their expectations and, in general, the Army and USMC acceptance of their new squad automatic has been enthusiastic.

Ammunition

Because the American M193 ammunition has an effective range of only 500m, the U.S.A. issued a request in 1972 for a type of ammunition having a better level of performance and enabling the user of a light machine gun to follow the squad's advance.

In its turn, NATO issued specifications whereby the new ammunition had to be able to halt the progress of lightly protected soldiers at a distance of 600m.

On the basis of these requirements, Fabrique Nationale decided to develop a ball cartridge, termed the SS109. The objectives were:

(a) to develop a 5.56 x 45mm calibre weapon system;

(b) to obtain, with the light machine gun, a level of performance close to that achieved with NATO 7.62mm ammunition:

(c) to considerably improve the existing M193 ammunition.

In fact, the SS109 bullet perforates a U.S. steel helmet at more than 1,200m, whereas the NATO 7.62 only perforates the same helmet up to 800m and the M193 to a bare 500m.

A second ammunition feed system is available and it is particularly timely when the machine gunner has exhausted all his ammunition. All he has to do to carry on firing is insert into his gun a 30mm cartridge rifle magazine of the FNC or M16A1 type without changing anything on the Minimi. This multi-feed system is unique.

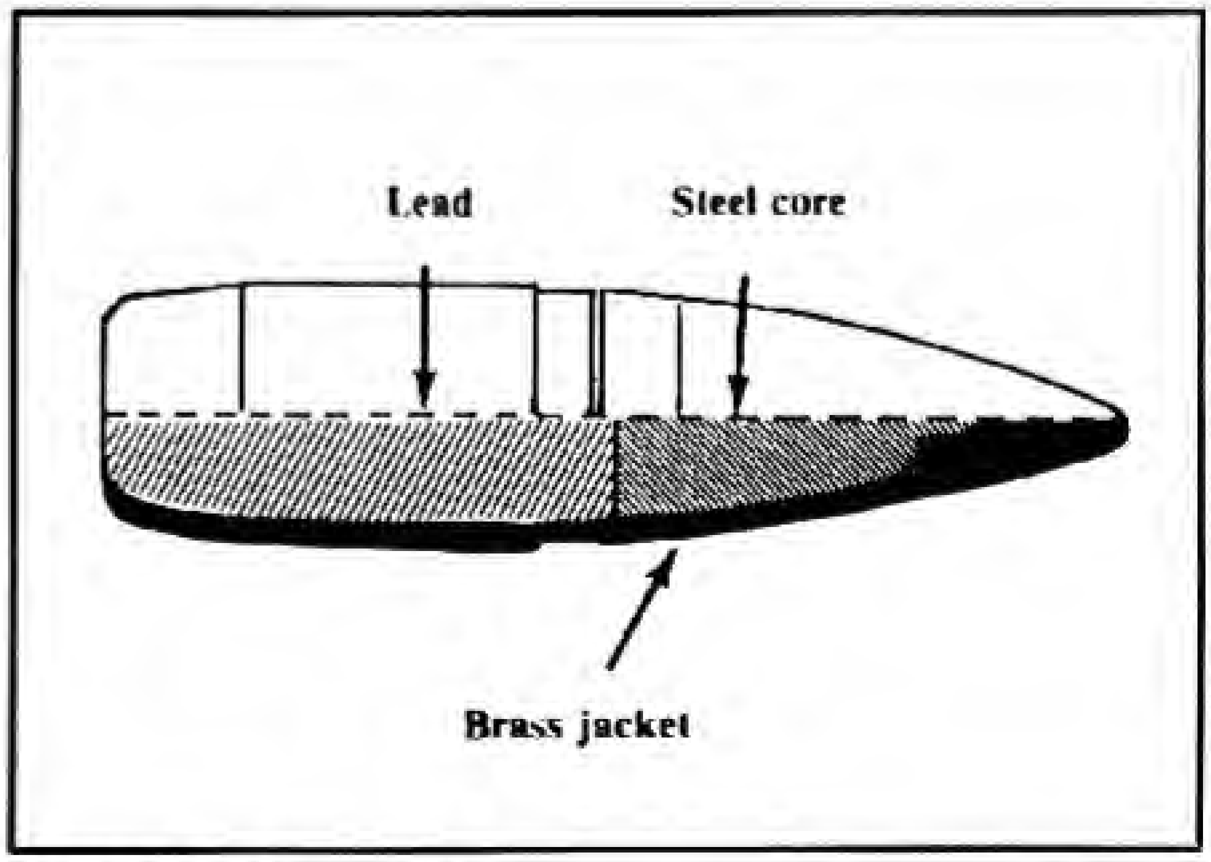
The purpose of this magazine feed is to enable the machine gunner to continue with his support role even when he has fired all his belt ammunition. He will then use the magazines of the rifles in the hands of the other members of the squad.

Another feature is the provision of an indicator, which can both be seen and felt when a cartridge is present on the feed tray.

After tests lasting more than five years, NATO selected the FN SS109 ammunition.

This organization has indeed adopted the best 5.56 x 45mm ammunition because, under the least favourable conditions (barrel with 12" rifling pitch), the performance level of the SS109 is at least equal to that of its closest rival and exceeds it by 30 to 50% when fired under optimum conditions (barrel rifling pitch of 178mm).

In practice, the SS109 is the only ammunition meeting the NATO and SAW criteria.

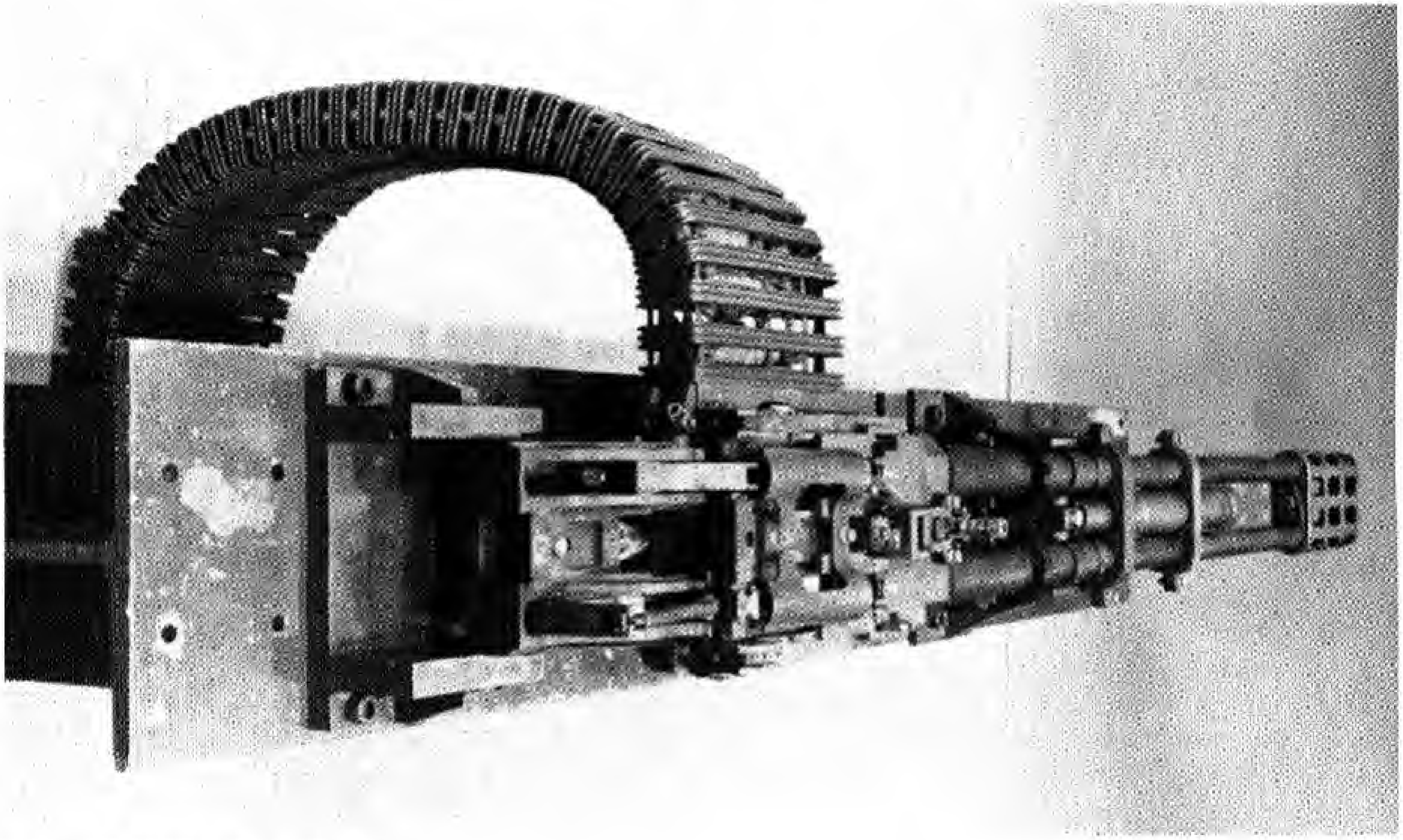


SS109 Bullet

Chapter 43

25mm GE 225 TWO BARREL GUN

GENERAL ELECTRIC

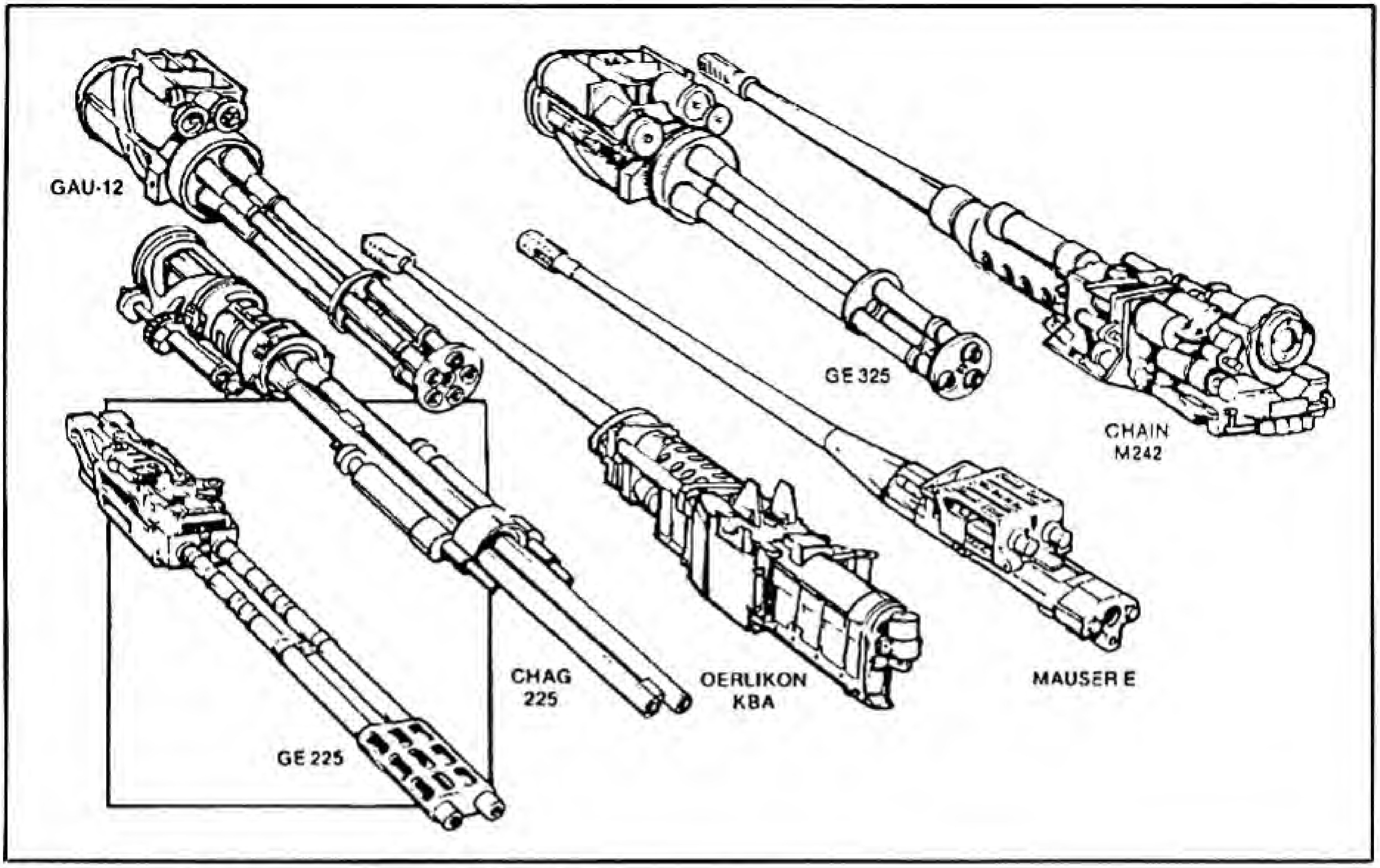


25mm GE 225 Two Barrel Gun

History

Early in the 1980's, General Electric surveyed foreign and domestic gun technologies to determine which 25mm size had the best characteristics for installation on small vehicles. One, a foreign gun, stood out from the others from the viewpoint of firing rates versus weight. This gun was a 23mm two-barrel, gas powered unit employing a unique motion multiplying mechanism and a one sprocket delinking feeder. The two barrels fire alternately but recoil in unison. When sized to handle the 25mm Bushmaster round, initial performance estimates showed this type mechanism capable of unequaled weight and rate of fire characteristics.

In 1982, a design study was made to thoroughly investigate the Gast-type of mechanism in a 25mm gun, to be designated the GE 225. Results showed that the GE 225 could be designed to fire at least 2000 spm and that it would weigh only 200 lbs. including recoil mechanism, feeder and gas drive, substantially more firepower and less weight than any comparable gun or concept.



Various 25mm Guns

Besides firing standard linked ammunition, several other important Weapon System Support and Readiness (WSSR) factors, were established as goals for the GE 225:

1) All parts designed to be interchangeable
2) The barrels to be automatically cleared of live rounds at the end of each burst
3) Variable rate of fire to permit the gun to be used in a wide variety of installations
4) Minimize and simplify scheduled and unscheduled maintenance actions
5) Design the basic gun so that installation of accessory parts such as muzzle brakes, gas or externally powered drive, recoil mechanism and alternate mounting features can be readily attached. The same basic gun design can, therefore, be used on a variety of vehicles.

The design of the GE 225 was accomplished early in 1983 and a single prototype gun fabricated and fired at about 500 spm with an external electric drive motor. Progress through 1984 included:

1) Designing, building and test firing a gas drive for the gun and demonstrating 1600 spm rate of fire. Three hundred thirty-four shots were fired.
2) Designing hardware to adapt the gun to the AH-1S helicopter turret.

Weight and Size Comparisons of 25-mm Guns

Gun	No. Barrels	Max. Firing Rate (spm)	Size (in.) L	Size (in.) W	Size (in.) H	Weight (lbs.)[1]
Chain Gun	1	475	108	13	15	230
GAU-12	5	4000	84	12	14	355
GE 325[2]	3	2400	84	13	14	265
CHAG 225[3]	2	2000	117	9	10	247
GE 225	2	2000	87	8	8	200
Mauser E	1	1000	112	12	10	225
Oerlikon KBA	1	570	113	10	12	183

[1] Includes gun, feeder, drive, controls

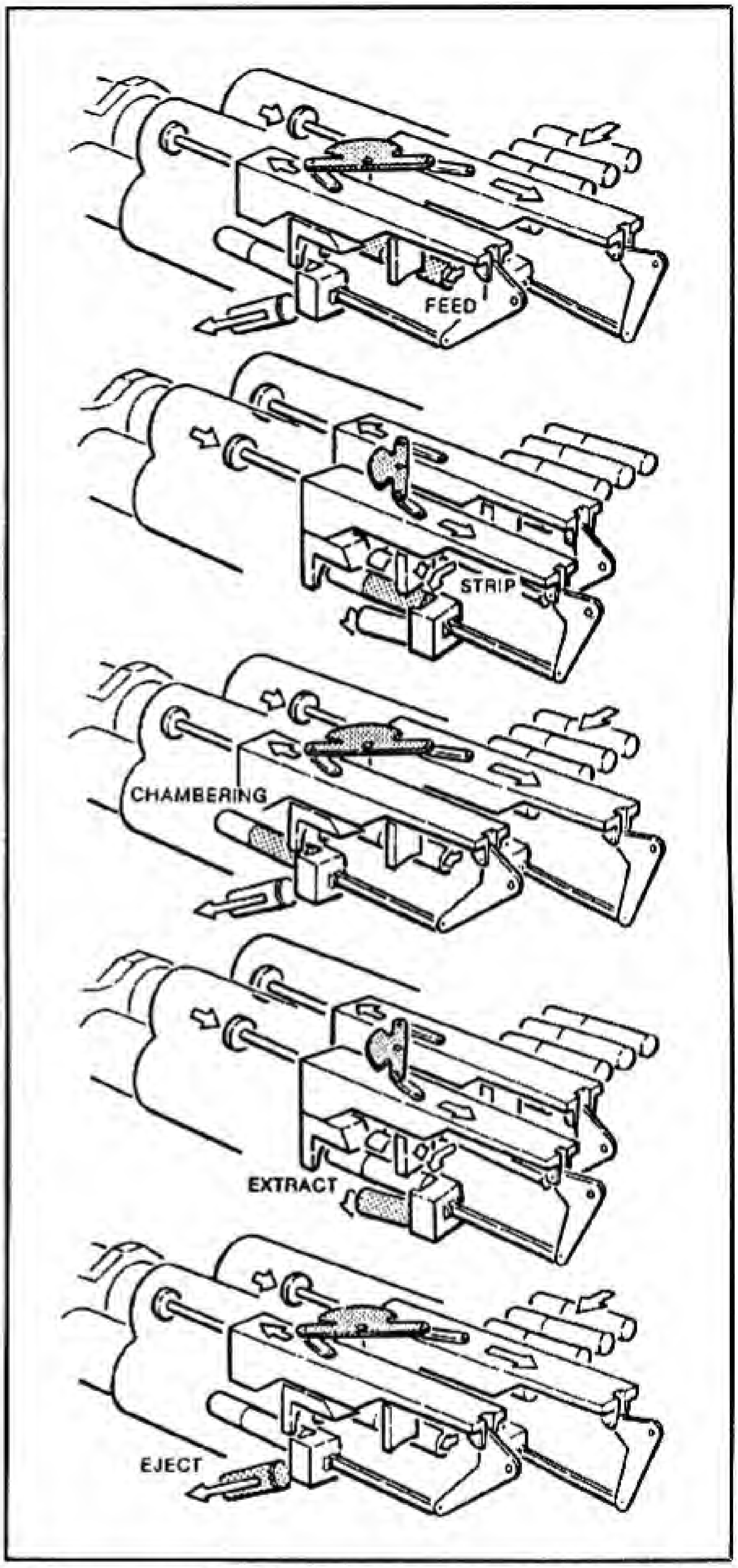
[2] A three-barrel derivative of the GAU-12 gun

[3] A two-barrel derivative of GE CHAG

Characteristics

Type	Gun gas or externally powered, lightweight, 2 barrel GAST, 25mm Weapon System
Length x Width x Height	87"X x 8.5"W x 8"H
Weight (Gun, Feeder & Drive)	190 lbs.
Power to Drive (for external drive)	15 HP @ 2000 spm 3 HP @ 750 spm
First Scheduled Maintenance	5000 rounds
Reliability	10000 MRBF
Ammunition	25mm Bushmaster Family (TP, HEI, API, APDS)
Muzzle Velocity	3600 FPS (1097M)/Sec. HEI 4200 FPS APDS
Dispersion (one sigma)	2 mil.
Rate of Fire	Variable to 2000 spm
Feed System	Linked
Recoil Force: Average @ 2000 spm	2300 lbs.
Average @ 750 spm	860 lbs.
Peak Max	*1800 lbs.
Peak Recurring	*1700 lbs.

*Values for the AH-1S Helicopter Turret firing at 750 spm



A Reciprocating Lever Synchronizes Firing and Round Flow.

Description

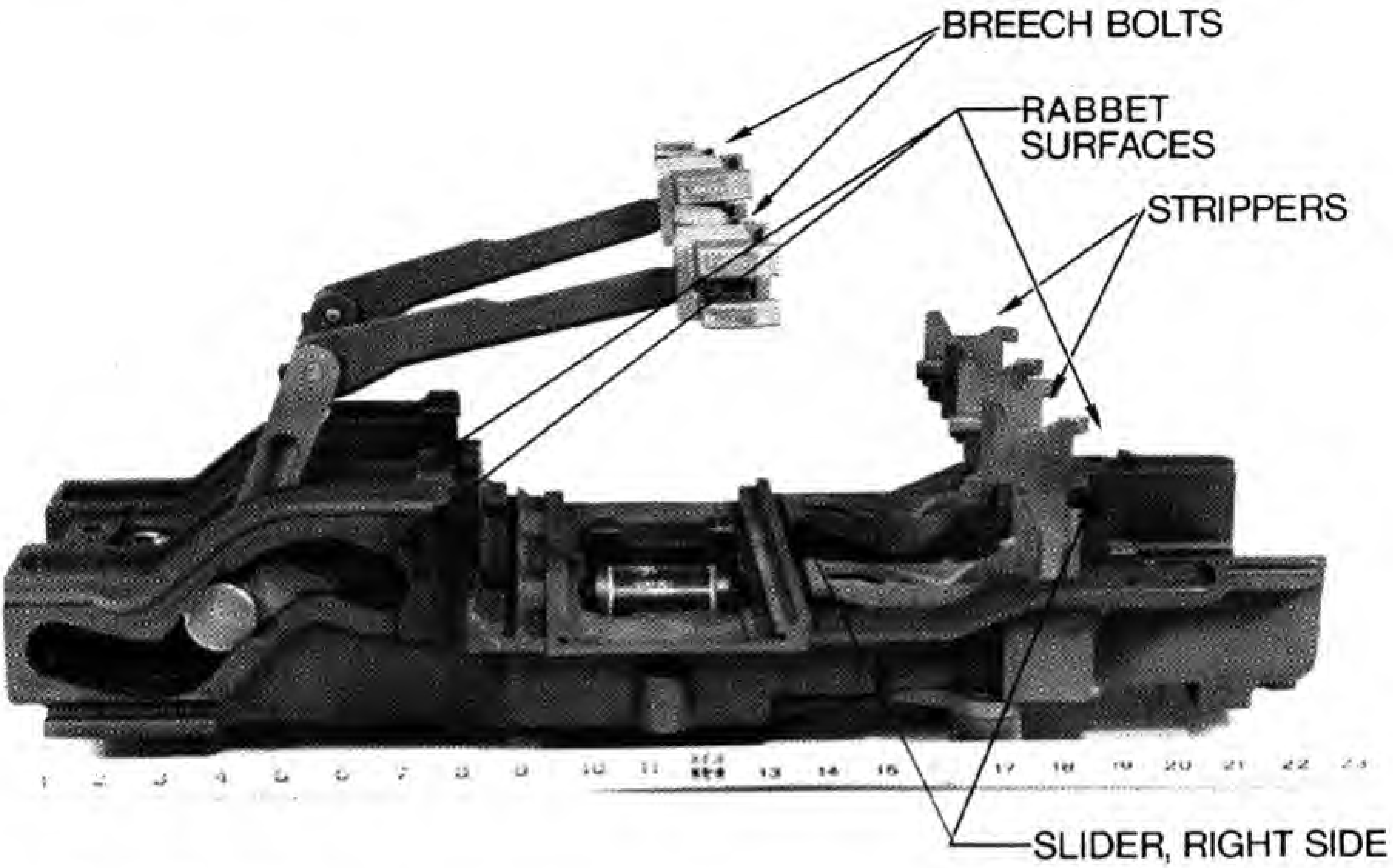
The GE 225 gun is a twin barrel weapon, capable of firing up to 2000 spm, either self-powered by gun gases bled from each barrel or externally powered by electric, hydraulic or pneumatic power sources. Common alloy steels have been used throughout with local hardening in areas of high stress and wear.

The gun consists of the following major subassemblies:

1. An upper housing assembly containing all the mechanisms to feed, ram, extract and eject the round.
2. A lower housing assembly containing the locking lugs for barrels and breech, the tracks that the breech bolts travel in, and all the guides that control the round during chambering, extraction and ejection.
3. A firing mechanism assembly containing the firing spring, hammer, firing solenoid, firing sear and safing pin.

Gun Mechanism. The gun mechanism consists of a pair of slides, accelerator links, connecting rods and breech bolts interconnected by a rocking lever that synchronizes their reciprocating motion.

Breech Bolt. The lightweight (0.85 pounds) breech bolt of this gun plays a key role in attaining high firing rate. The firing pin has no stored energy behind it (i.e., no spring) and is not in line with the primer until the breech is fully locked, thus eliminating any possibility of detonating a round out of battery. The bolt is displaced laterally to lock the



Receiver Housing Assembly

breech, align the firing pin with the primer and position the firing pin within striking range of the firing hammer. Two pairs of extractors control the round and cartridge case during ramming, extraction and ejection.

Feeder. The feeder is simple and consists of parts contained in the receiver housing. A sprocket advances the ammunition belt through the gun where cam actuated strippers push each round out of its link. The sprocket is powered by a drum cam that, in turn, is driven by the gun linkage. Feeding can be from either side by reversing the drum cam, clutch, and feed sprocket.

Firing Mechanism. A spring loaded firing hammer is located centrally between the two breeches and is designed to strike each of the two firing pins alternately. The hammer is prevented from striking the firing pin until the breech bolt is safely locked by a mechanical sear. A solenoid operated sear holds the hammer from striking until an electric "fire" signal is received. A mechanical safing pin (to be removed before firing) provides additional safing during maintenance and other ground operations.

The firing hammer and spring are designed to provide a three millisecond hammer fall time and deliver a minimum of 40 inch-pounds of energy to the firing pin which is more than adequate to detonate the primer of the Bushmaster round.

Recoil Mechanism. The recoil mechanism mounts between the barrels and provides attenuation of recoil force and also serves as the forward gun mount. Internally, ring springs are stacked in series to allow gun motion and to supply damping.

Gas Drive. The gas drive as designed and fabricated in 1984 was improved in 1985 to facilitate the squib package.

Modeled on the computer, the gas drive was then superimposed on the analytical model of the gun previosuly developed during the gun design phase. The pistons were sized to provide adequate power to start the gun with a peak pressure of 1,000 psi, making the drive compatible with either a squib type starter or a 3000 psi pneumatic reservoir, blow down type starter. The model was also used to determine the sensitivity of the drive to variations in friction and gas port diameter. As expected, both friction and barrel port diameter are significant variables.

The prototype gas drive mounts just forward of the gun housing, consists of separate parts that are fastened together and to the gun barrels. The major parts are:

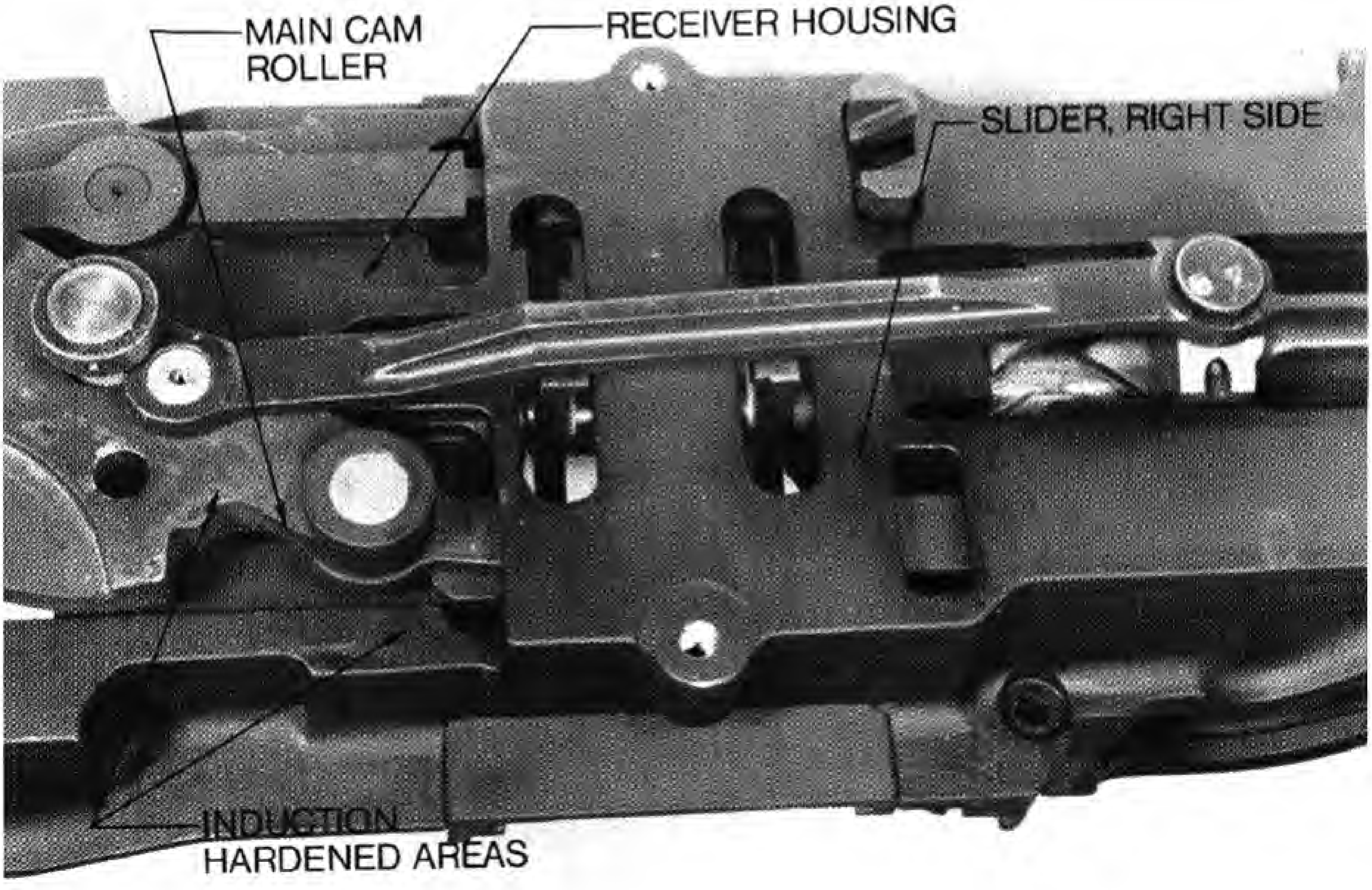
a. Cylinder housings - mounted to each barrel, the cylinder housings are ported to bleed gun gases from the barrel into the housing where they act against a piston.
b. Piston - each cylinder housing contains a chromium plated piston locked to the gun's operating linkage, permitting gas pressure on the piston head to operate the gun.
c. Valve housing assembly - spanning both cylinders the valve housing is bolted to the receiver housing and contains valves that direct high pressure gases from the squib starter to the correct piston, i.e., the one that is nearest the back of the gun.
d. Clearing assembly - a 28 vdc solenoid operates a spring returned lever that normally is engaged in the gun mechanism to prevent cycling of the gun unless the solenoid is energized. To clear the gun, the solenoid is de-energized just before the last round fires, leaving a fired case chambered and the next live round held back completely out of its chamber.

Cycle of Operation

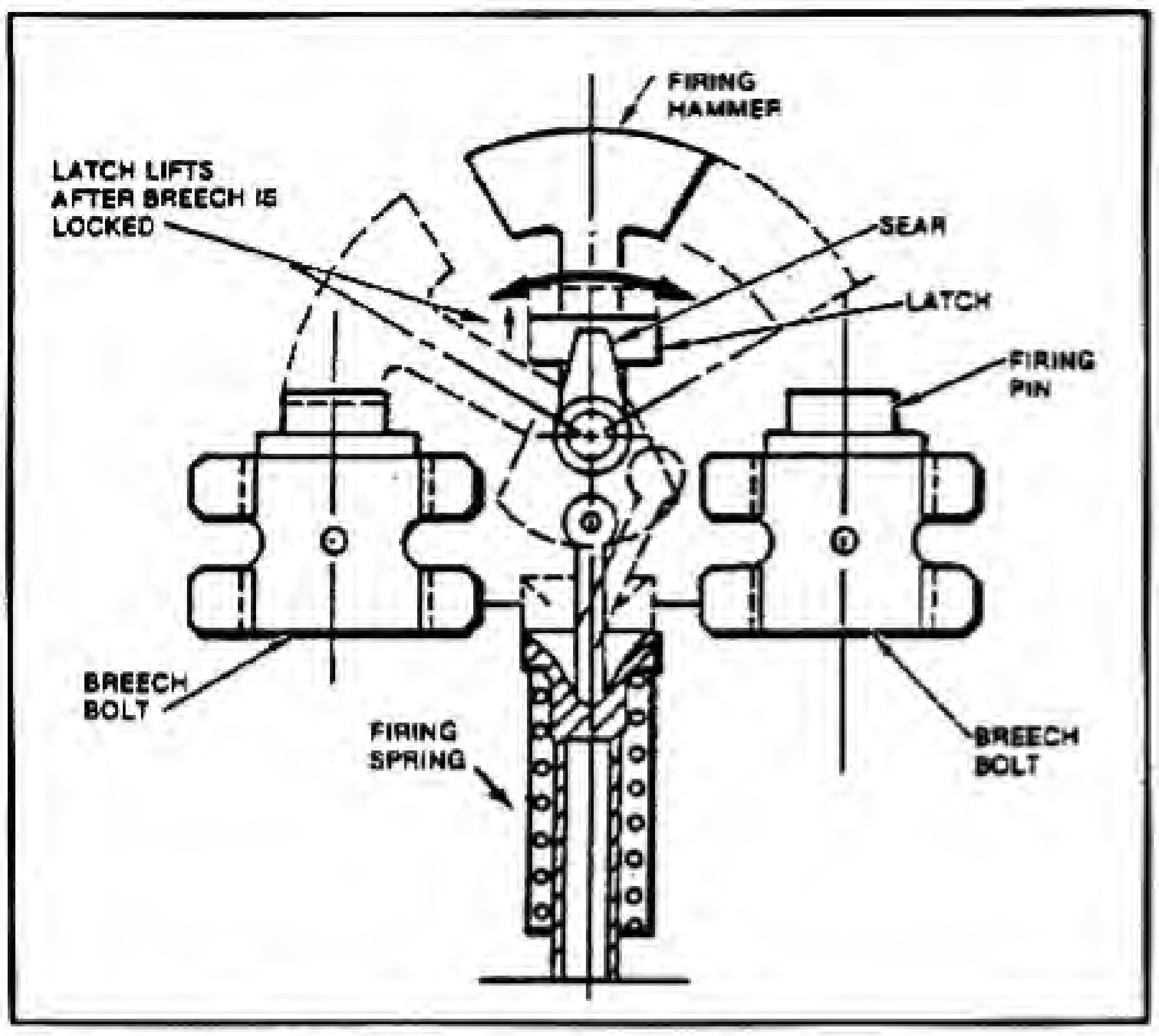
The basic GE 225 gun is comprised of the following assemblies:

Receiver Housing Assembly
Breech Housing Assemblies
Two Barrels
Firing Mechanism Assembly

The two housings are fastened together by four 8mm bolts. The barrels are inserted into the breech housing and rotated 90° to lock. The firing mecha-



Receiver Housing Assembly

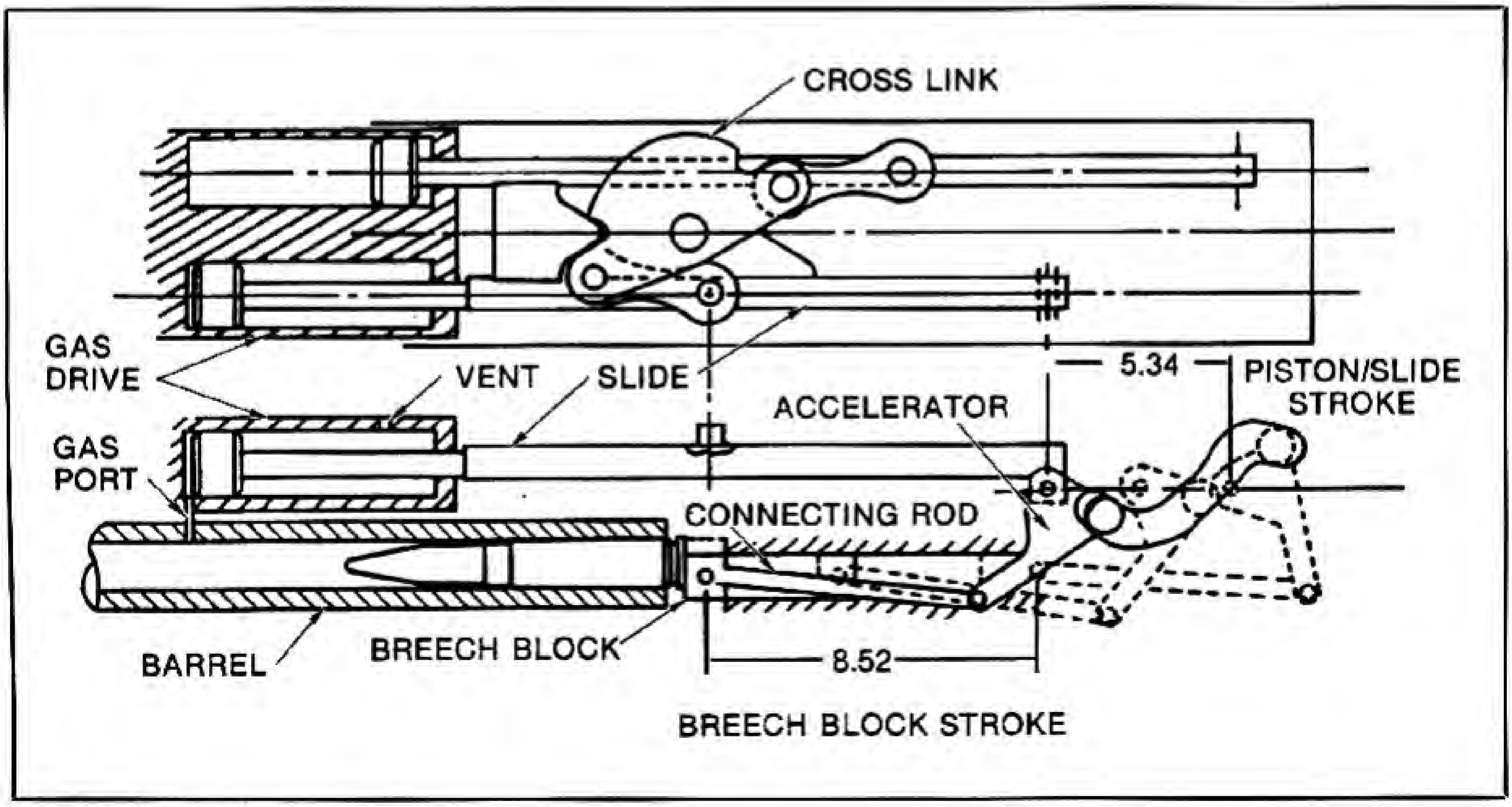

FIRING HAMMER
LATCH LIFTS AFTER BREECH IS LOCKED
SEAR
LATCH
FIRING PIN
BREECH BOLT
FIRING SPRING
BREECH BOLT

Gun Linkage Mechanism

nism attaches to the breech housing with three 8mm bolts. Once assembled in this manner the basic gun is complete. However, accessory equipment is required to make the gun operable. Accessories include a drive, either gun gas powered or externally powered; muzzle device and recoil attenuators.

The gun design is based on the GAST principle of operation with the barrels side-by-side in a common gun housing. It is a symmetrical arrangement with each side consisting of a breech bolt assembly, connecting rod, accelerator, slide and connecting link. At the mid point the rocking lever connects each slide together. Except for the breech bolts, which are in the breech housing, all of this linkage is contained in the receiver housing. When powered by gun gases which are bled from the barrels, a piston rod which pushes directly on the front of its respective slide generates the force required to operate the gun linkage. The piston will travel 5.34 inches rearward and, through the rocking lever, will cause the right slide and piston to move forward the same distance thereby making the gun ready for the right barrel to fire.

While the slides move back and forth, as described, the accelerators move with them. At the same time another point on the accelerators follows the main "S" shaped cam through the action of a roller. The result is that the motion of the extremity of the accelerators that are pinned to the bolt connecting rods are caused to move a greater distance than the slides. In this way the breech bolts are caused to travel 8.52", the distance required to chamber the 25mm round. A dwell is provided which allows the bolts to remain stationary at the ends of their travel

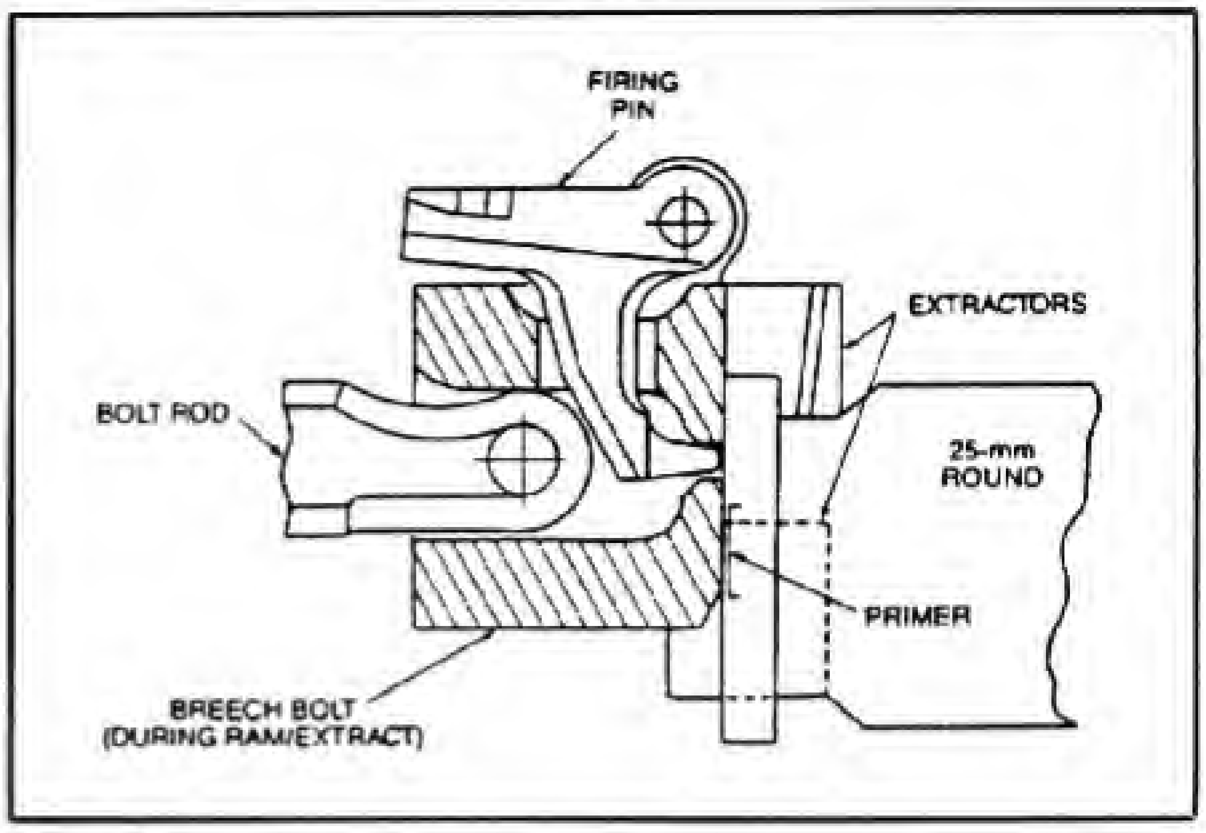

CROSS LINK
GAS DRIVE
VENT
SLIDE
ACCELERATOR
5.34
PISTON/SLIDE STROKE
GAS PORT
CONNECTING ROD
BARREL
BREECH BLOCK
8.52
BREECH BLOCK STROKE

Basic Gun Mechanism

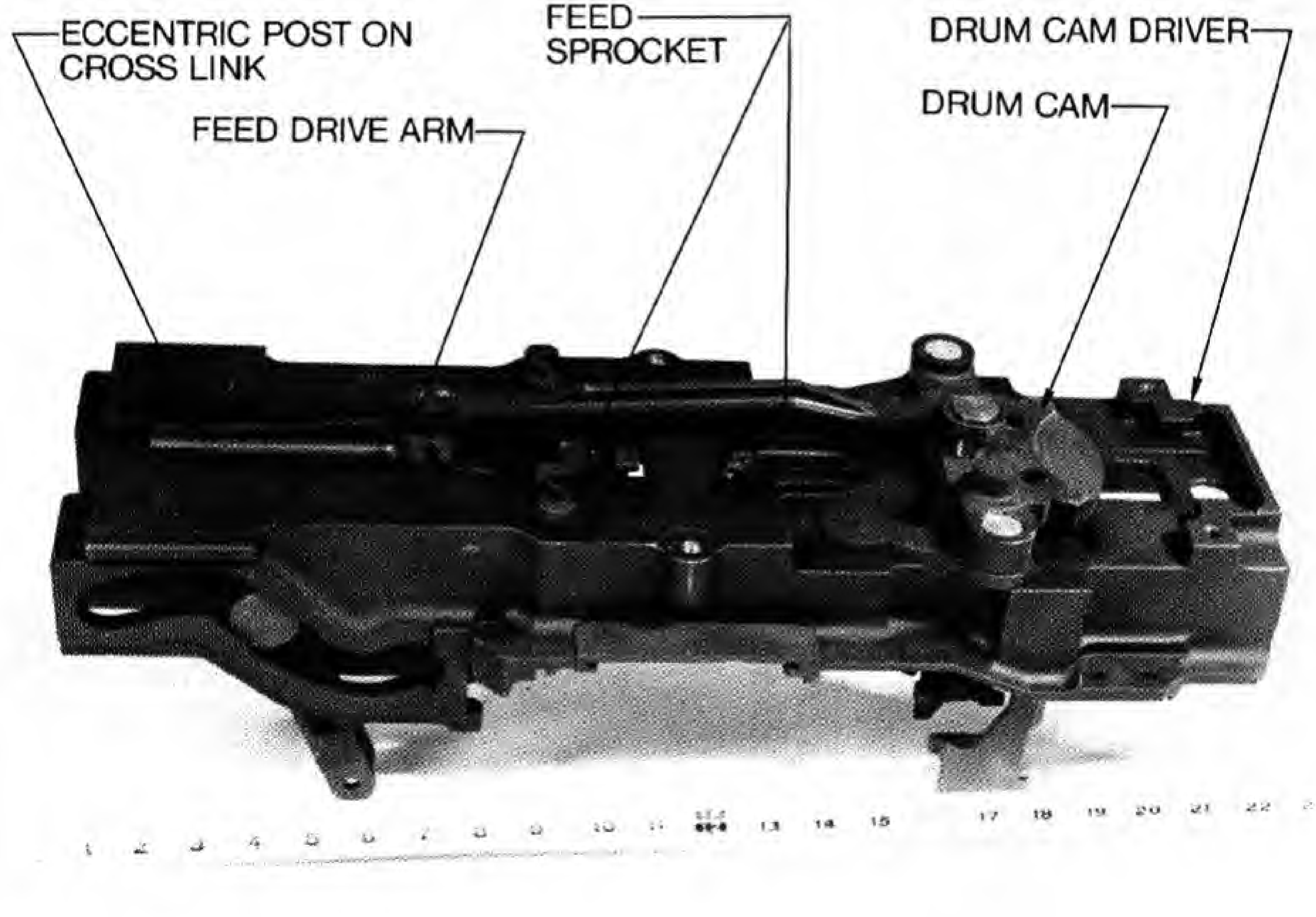
even though the slides are still moving, thereby allowing time to fire the next round (forward dwell) and to feed another round (rear dwell).

The gun linkage also drives the feeder through a drum that is eccentrically attached to the rocking lever. Motion thus generated is converted to intermittent rotary motion of a feed sprocket by the action of a drum cam. Synchronized with the sprocket is the motion of two round strippers which are cammed directly by the slides. One pushes on the neck of the cartridge and the other on the base. Together they side strip the round from a metallic link and eject downward from each barrel.

Rotational motion of the rocking lever is arrested at the end of each stroke of the gun's linkage by a sliding detent. This member is spring loaded against the rocking lever and also has cam surfaces which act to draw the detent into engagement with the rocking lever thereby preventing any tendency of the linkage to rebound.


FIRING PIN
EXTRACTORS
BOLT ROD
25-mm ROUND
PRIMER
BREECH BOLT (DURING RAM/EXTRACT)

Firing Pin


ECCENTRIC POST ON CROSS LINK
FEED SPROCKET
FEED DRIVE ARM
DRUM CAM DRIVER
DRUM CAM

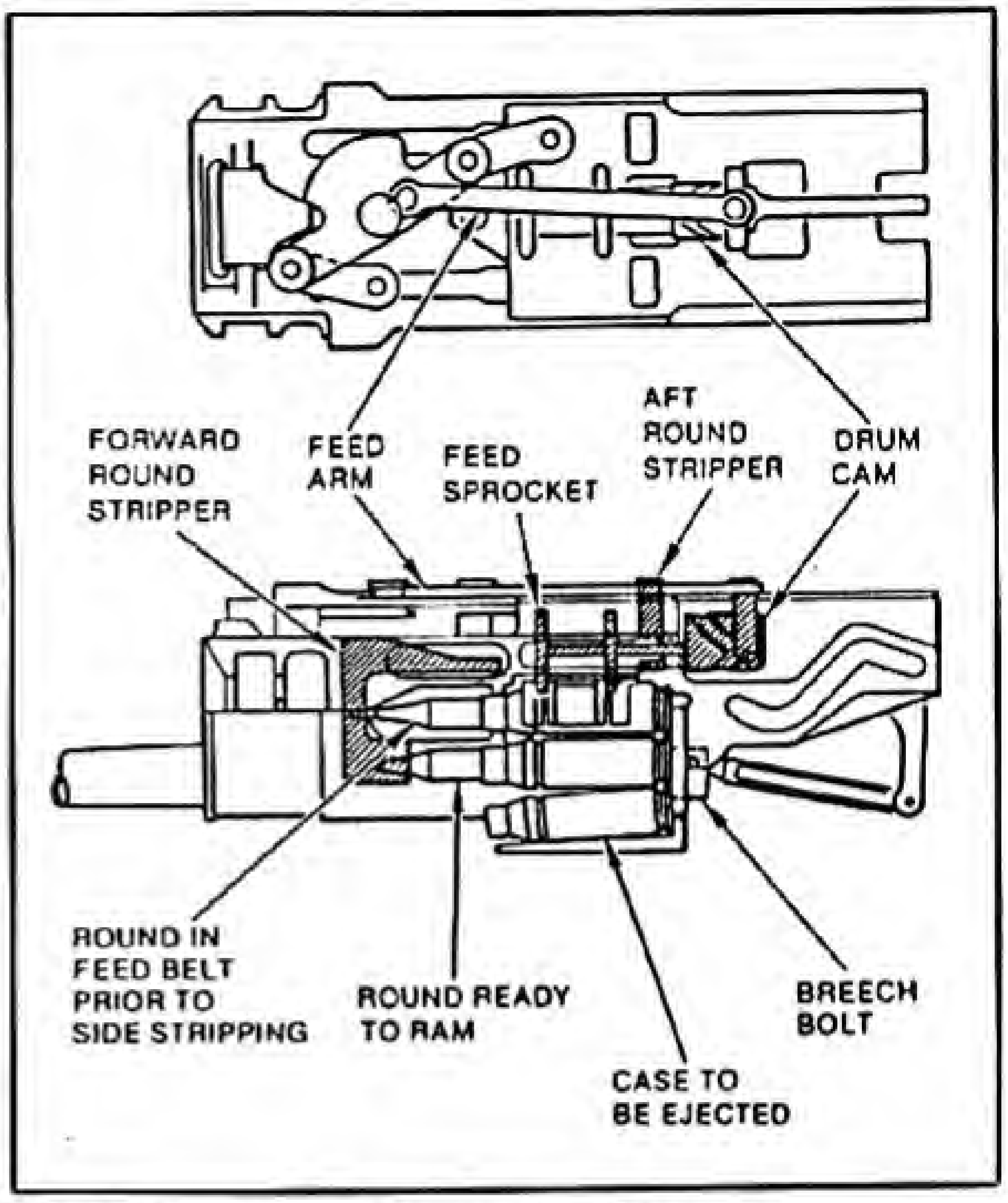
25mm GE 225 Feeder

The firing mechanism fires each round by percussion. The energy is delivered by a single hammer that lies at the gun centerline and pivots about an axis parallel to the direction of fire. A large coil spring, housed in the breech housing, is eccentrically connected to the hammer. After a breech bolt assembly has completed its forward stroke it is raised 12mm to lock it in the breech. The hammer then pivots against the firing pin causing it to rotate into the primer. The barrels fire alternately.

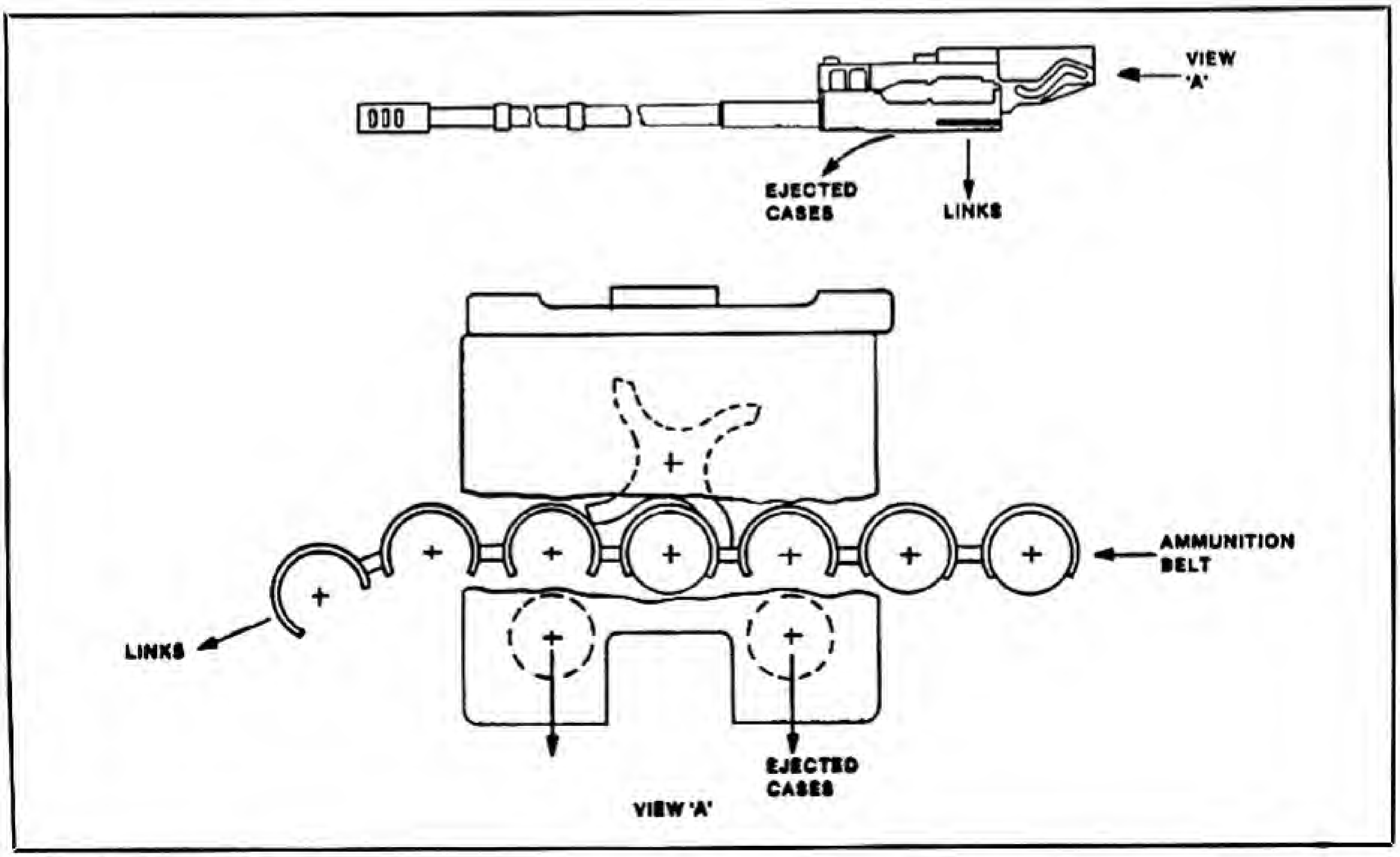
All live rounds are automatically cleared from the chambers at the end of each burst. To provide full adaptability the ammunition feed system can be installed to feed either side of the gun. This lightweight two-barrel, 25mm gun has been designed to meet a variety of military needs in the future of air and surface applications.

Bushmaster 25mm Ammunition

Excellent ballistics and proven results are obtained from the Bushmaster 25mm family of ammunition. This ammunition produces a muzzle velocity of 4200 feet per second (APDS). It provides improved time of flight, better penetration capability and greater


FORWARD ROUND STRIPPER
FEED ARM
FEED SPROCKET
AFT ROUND STRIPPER
DRUM CAM
ROUND IN FEED BELT PRIOR TO SIDE STRIPPING
ROUND READY TO RAM
CASE TO BE EJECTED
BREECH BOLT

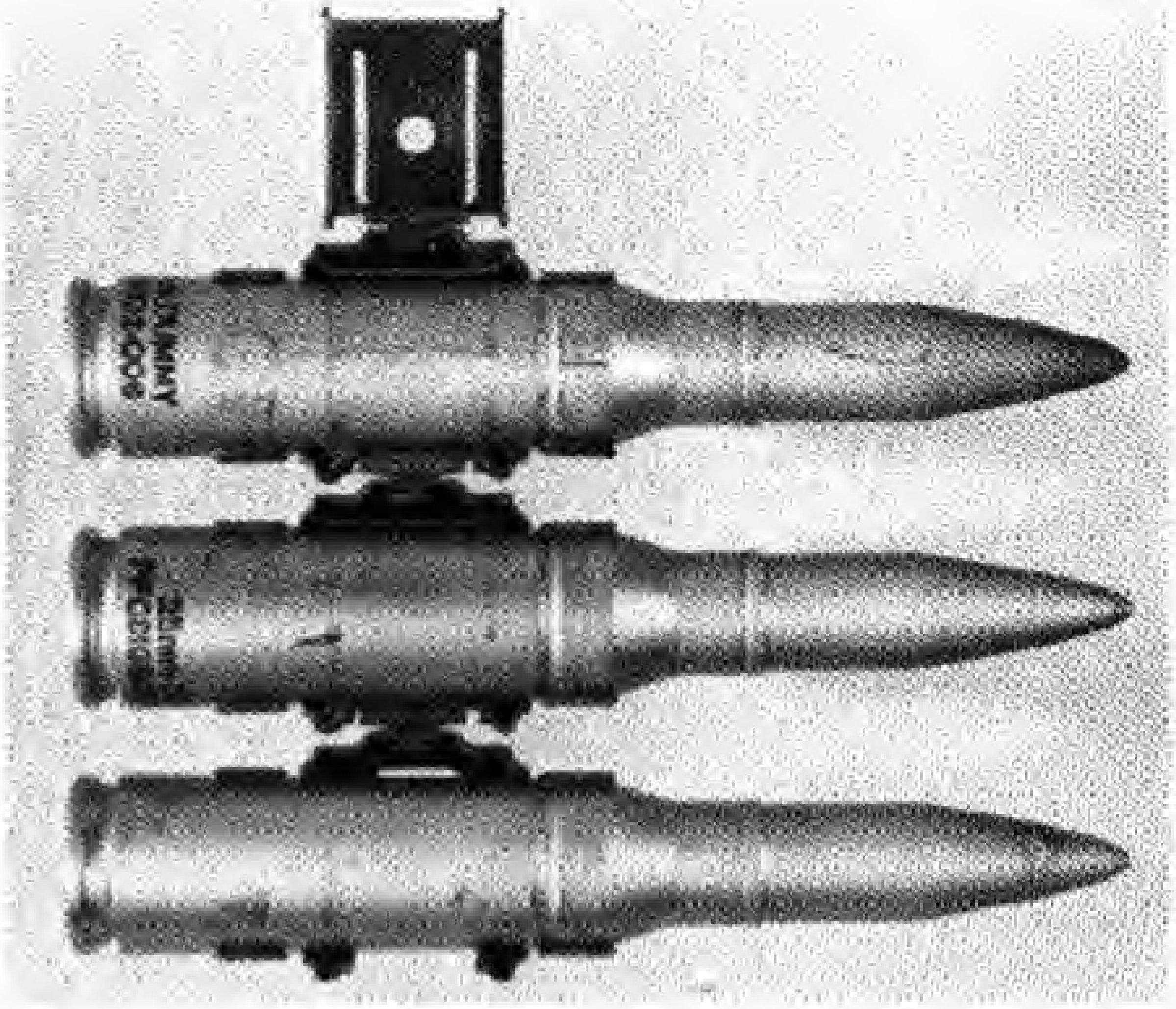
Feeder Components/Feeding and Delinking


VIEW 'A'
EJECTED CASES
LINKS
AMMUNITION BELT
LINKS
EJECTED CASES
VIEW 'A'

GE 225 Ammunition Flow

lethality than 20mm ammunition. For helicopter applications, air-to-air capability is improved dramatically with 25mm, including increased effectiveness against light armored vehicles.

The two standard series of 25mm ammunition are percussion primed and steel cased. The M790 series include TP, HEI and APDS, while the newly developed GPU 20/U series provides API capability for high performance aircraft.

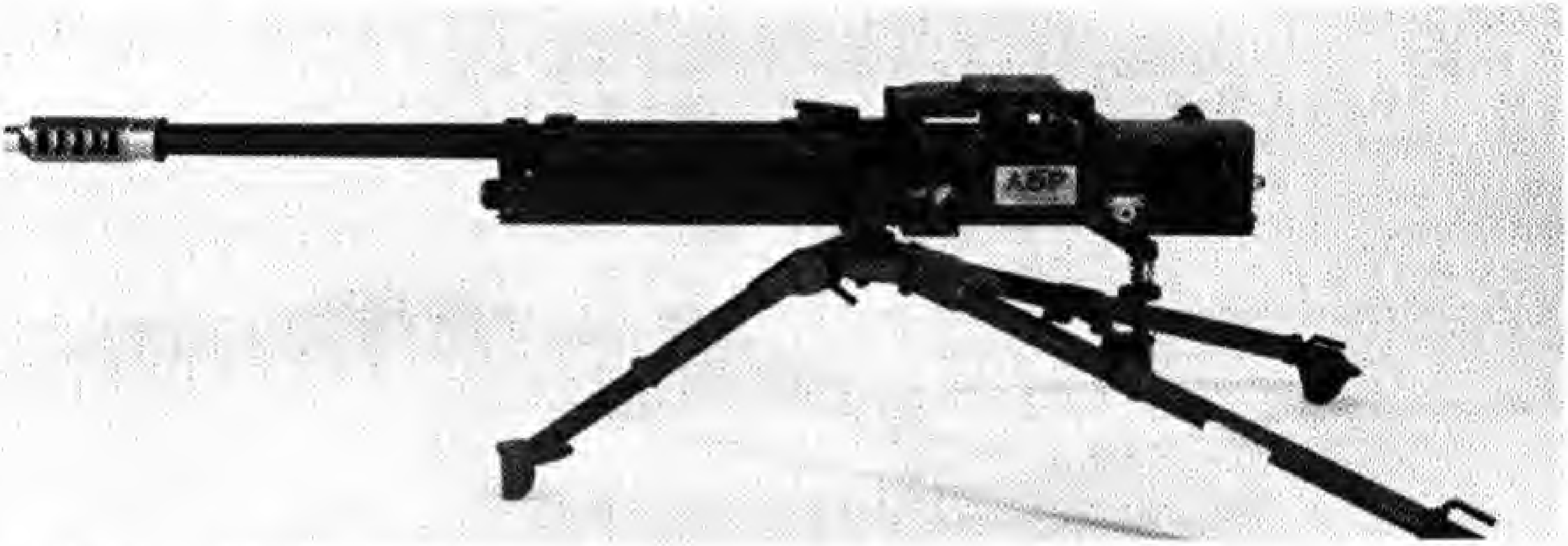


Bushmaster 25mm Ammunition

Chapter 44

30mm ASP (AUTOMATIC SELF-POWERED) CANNON

McDONNELL DOUGLAS HELICOPTER COMPANY



30mm ASP (Automatic Self-Powered) Automatic Cannon

History

According to McDonnell Douglas Helicopter Company, they are developing a 30mm lightweight, self-powered, automatic cannon which is readily interchangeable with calibre .50 M2HB machine guns. This weapon, firing inventory 30mm M789 HEDP or interoperable ADEN/DEFA ammunition, provides an order of magnitude improvement in firepower from a variety of pintlemount installations on light combat vehicles. Gas operated and, therefore, mount insensitive, it can be easily removed from the vehicle for tripod mounting in the leg infantry support role. The ASP-30, with built-in dual acting recoil adapters and providing semi-automatic or automatic fires of 400–450 shots per minute, weighs 115 pounds (complete) without need for a cradle or other cumbersome adaptive hardware required by contemporary weapons. The short length behind the feed permits simplified and fully controlled "spade grip" firing from cupola mounting

Characteristics

Calibre	30mm
Ammunition	ADEN/DEFA/M788/M789/M799
Weight	115 lb.
Rate of Fire	Semi-Automatic and 400–450 rpm
Muzzle Velocity	2650 fps
Locking Mechanism	Rotating Bolt
Method of Operation	Gas; Straight Expansion Type
Recoil Adapter	Built in; Dual Acting
Mounting Provisions	Identical to Browning M2HB
Length	79.8 in.
Width	8.0 in.
Height	9.5 in.
Barrel Length	52.0 in. (58.0 in. with Blast Suppressor)
Direction of Feed	Left Hand
Length Behind Rear of Feed	11.5 in.

structures.

The service approved 30mm M739 High Explosive Dual Purpose ammunition features penetration and fragmentation characteristics which meet or exceed all NATO requirements. M789 ammunition demonstrates outstanding penetration out to 4,000 meters and can defeat the BMP fighting vehicle threat at engagement ranges of interest. This round offers a multi-role, multi-target capability, enhances survivability by providing longer standoff than currently available infantry support weapons and ensures a large, lethal area of blast concussion and fragmentation.

SECTION I.

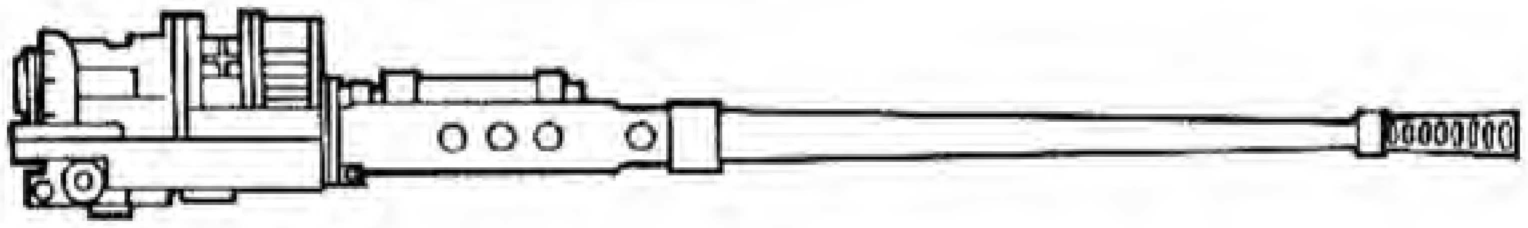
McDONNELL DOUGLAS WEAPON FAMILY

McDonnell Douglas Helicopter Company is the world's largest producer of automatic cannons and has been developing, producing and integrating ordnance systems for nearly 50 years.

The company's family of Chain Gun weapons—reliable, externally powered chain-driven guns—and other ordnance innovations shown on these pages, continue to play an important role in the defense of the free world aboard military land, air and sea vehicles.

McDonnell Douglas Helicopter Company's ordnance tradition can be traced to World War II when company engineers developed the first flexible ammunition feed chute for combat aircraft.

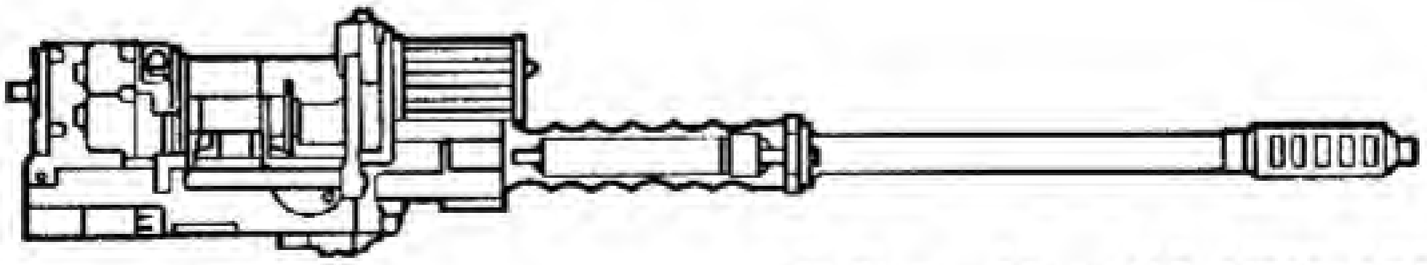
This pioneering spirit lives on at McDonnell Douglas Helicopter Company, where advanced ordnance developments are helping the company keep a bead on the future.



25mm M242 Bushmaster

Dual feed, externally powered cannon using patented Chain Gun® action for vehicle or shipboard mounting. Standard on M2/M3 Bradley Fighting Vehicles and LAV-25. (Bushmaster II, a larger version of the M242, is in development.)

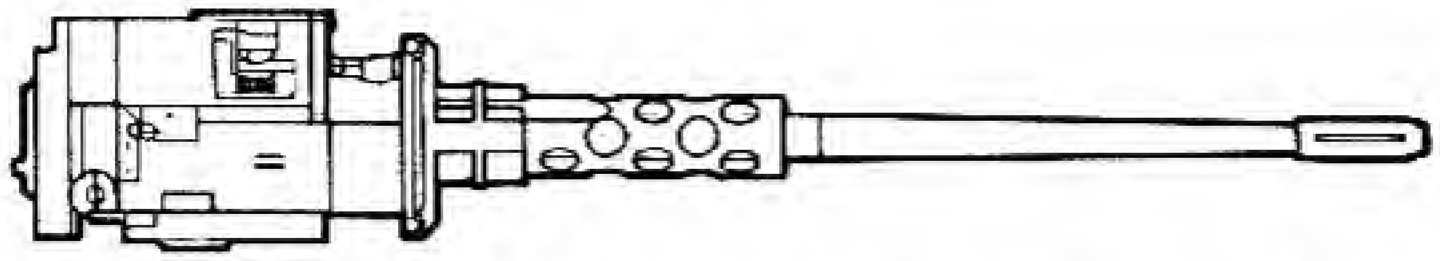
Caliber: 25mm U.S. M790 Series, NATO
Rate of Fire: SS, 100, 200, 500 spm
Weight: 244 lb
Dimensions: 108.7"L x 13"W x 15"H
Date Developed: 1976
Number Produced: In Production



30mm M230 Cannon

Chain Gun® action cannon. Developed for use in the AH-64A Apache attack helicopter Area Weapon System.

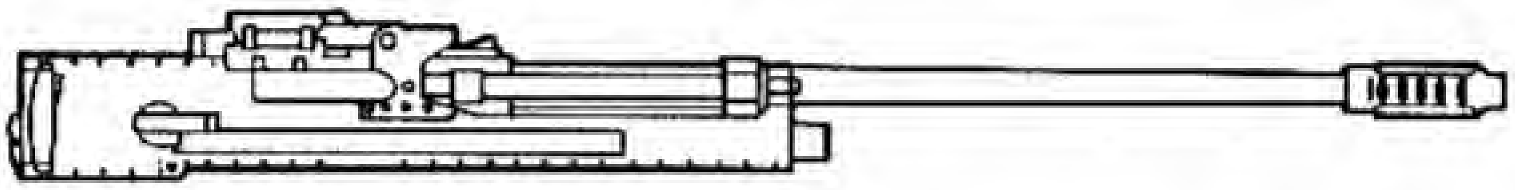
Caliber: 30mm U.S. M789; ADEN, DEFA
Rate of Fire: 625 spm
Weight: 118 lb
Dimensions: 64.5"L x 10"W x 11.5"H
Date Developed: 1972
Number Produced: In Production



7.62mm EX-34 Machine Gun

Chain Gun® type machine gun for vehicle or helicopter use. Produced by Royal Ordnance, Enfield, under license.

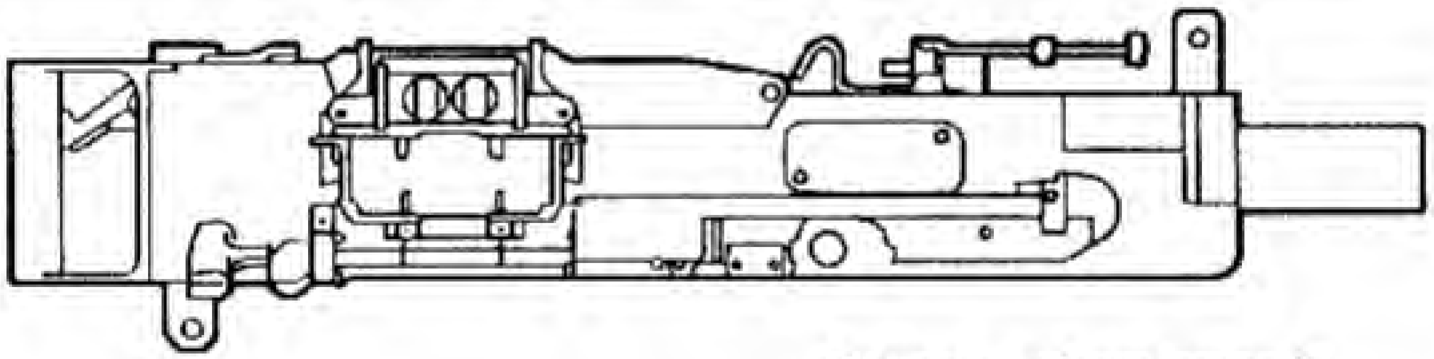
Caliber: 7.62mm NATO Std
Rate of Fire: 550 spm
Weight: 28 lb
Dimensions: 37"L x 6"W x 6.1"H
Date Developed: 1974
Number Produced: In Production



30mm ASP-30 Cannon

Self-powered, single-barrel cannon for tripod or vehicle mounting. Uses same ammunition as M230 for AH-64A Apache.

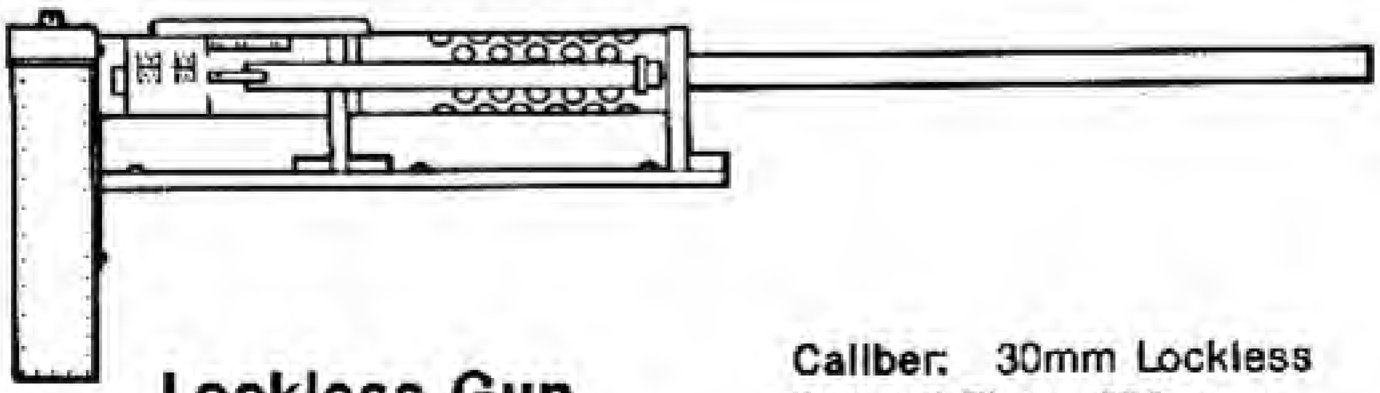
Caliber: 30mm U.S. M789; ADEN, DEFA
Rate of Fire: SS, 400 spm
Weight: 105 lb
Dimensions: 79.8"L x 8"W x 9.5"H
Date Developed: In Development



40mm XM175

Self-powered, high-velocity grenade launcher for both tripod and vehicle applications.

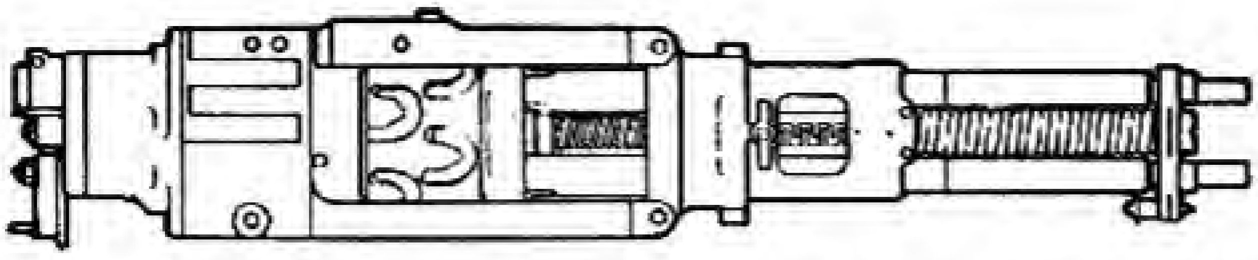
Caliber: 40mm grenade
Rate of Fire: 350 spm
Weight: 35 lb
Dimensions: 35.4"L x 8.9"W x 5.5"H
Date Developed: 1964
Number Produced: 17



30mm Lockless Gun

Automatic gun fixture. Recoil operated, pneumatically fed, 50-round magazine. Fires fully telescoped, plastic encapsulated ammunition of unique design.

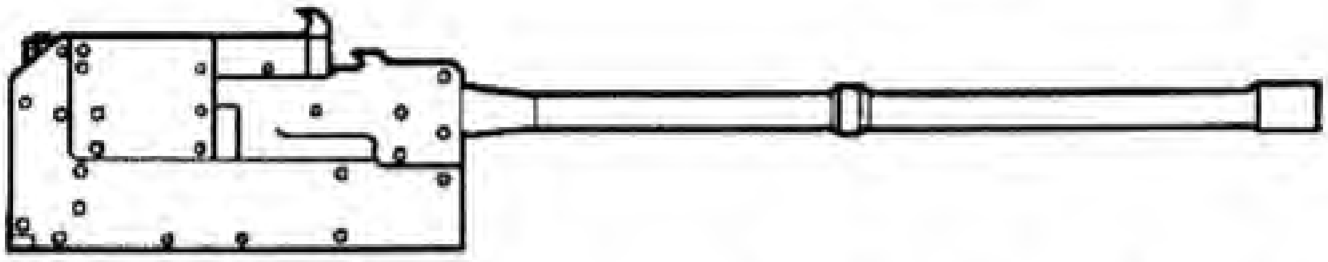
Caliber: 30mm Lockless
Rate of Fire: 350 spm
Weight: 250 lb
Dimensions: 110"L x 11.75"W x 11"H
Date Developed: 1972
Number Produced: 1 Prototype



7.62mm Heligun

Self-powered, two-barrel, high-rate-of-fire machine gun. Used same type of gun action as 20mm Mk 11 Gun.

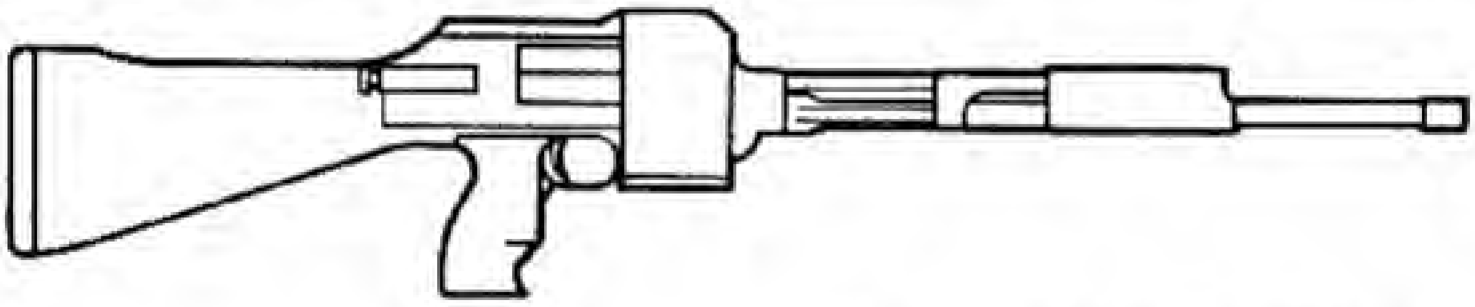
Caliber: 7.62mm NATO Std
Rate of Fire: 6000 spm
Weight: 30 lb
Dimensions: 30"L x 4"W x 5"H
Date Developed: 1963
Number Produced: 8



7.62mm EPAM Gun

Light dual-feed, externally powered armor machine gun (EPAM) for vehicle mounting. Used internal motor and barrel cam. Led ultimately to Chain Gun® concept.

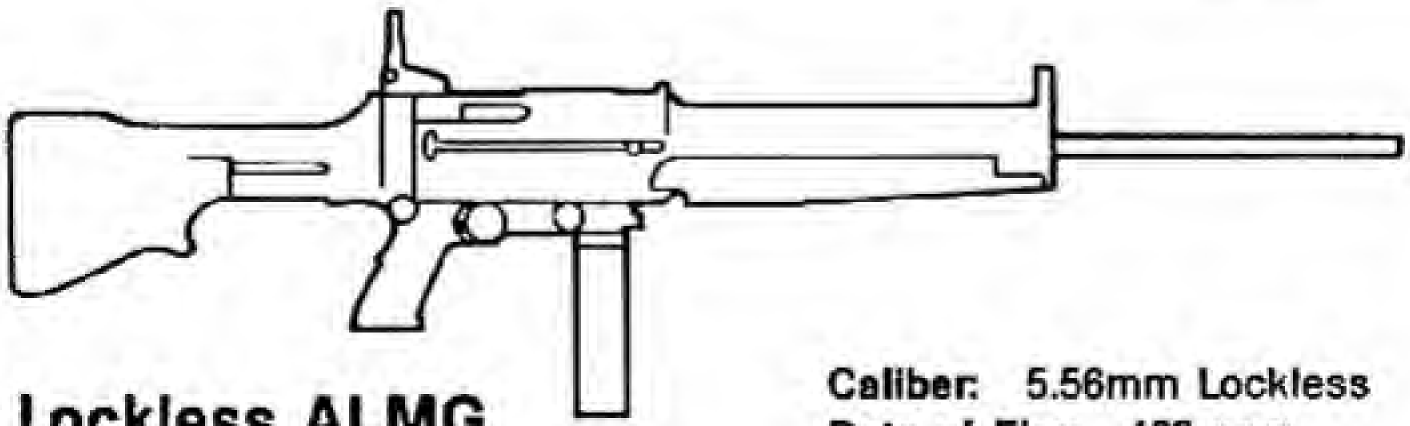
Caliber: 7.62mm NATO Std
Rate of Fire: 600 spm
Weight: 29.5 lb
Dimensions: 31.3"L x 4"W x 5.8"H
Date Developed: 1970
Number Produced: 1 Prototype



5.56mm High-Rate-of-Fire Rifle

Gas operated, linear-action chamber mechanism. Hand-held weapon with 64-round magazine, fires three-round burst.

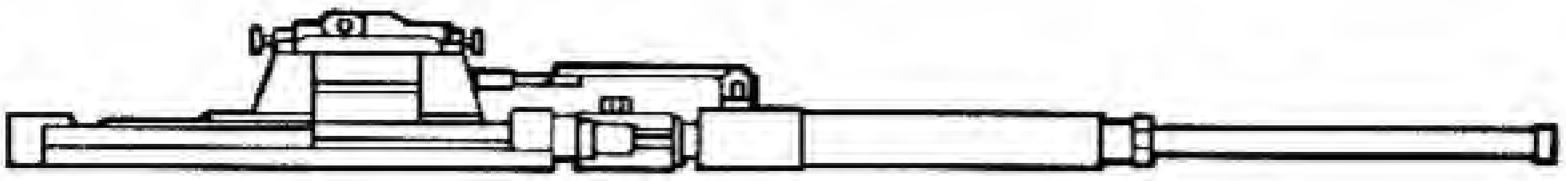
Caliber: 5.56mm NATO Std
Rate of Fire: 8000 spm
Weight: 10 lb
Dimensions: 43"L x 4.8"W x 5"H
Date Developed: 1970
Number Produced: Mock-up



5.56mm Lockless ALMG

Concept demonstrator for an Advanced Light Machine Gun (ALMG) with a lockless breech mechanism. Hand-held and bipod machine gun.

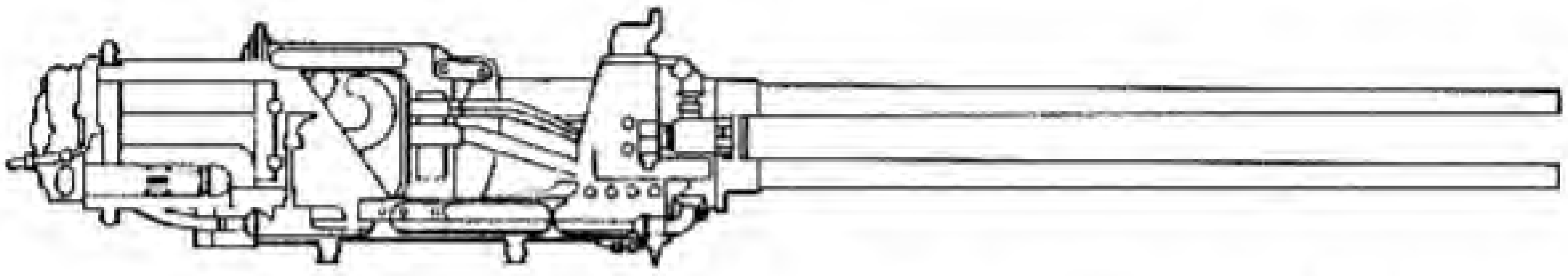
Caliber: 5.56mm Lockless
Rate of Fire: 420 spm
Weight: 18 lb (with 200 rounds)
Dimensions: 43"L x 6.5"W x 6"H
Date Developed: 1971
Number Produced: 1



30mm Mk 4 Gun

Single-barrel, Hispano-type gun for aircraft use. (Not related to Mk 4 Gun Pod.)

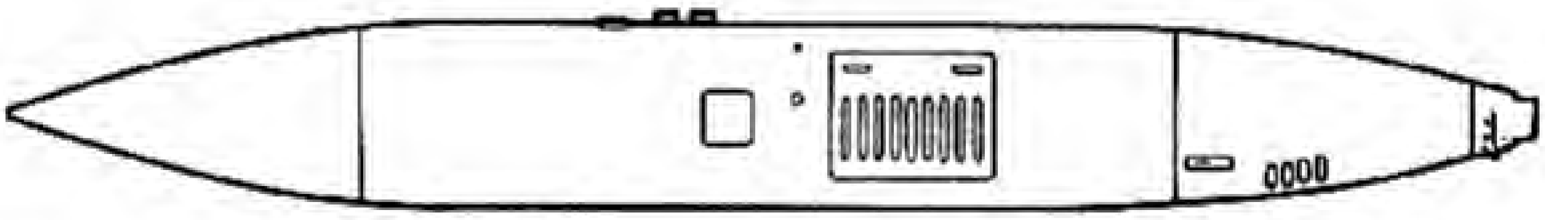
Caliber: 30mm U.S. T239
Rate of Fire: 1000 - 1200 spm
Weight: 103 lb
Dimensions: 76"L x 8"W x 7"H
Date Developed: 1949
Number Produced: 12



20mm Mk 11 Gun

High-rate-of-fire, two-barrel, self-powered cannon especially for installation in Mk 4 Gun Pod used with U.S. Navy/Marine Corps fixed wing aircraft.

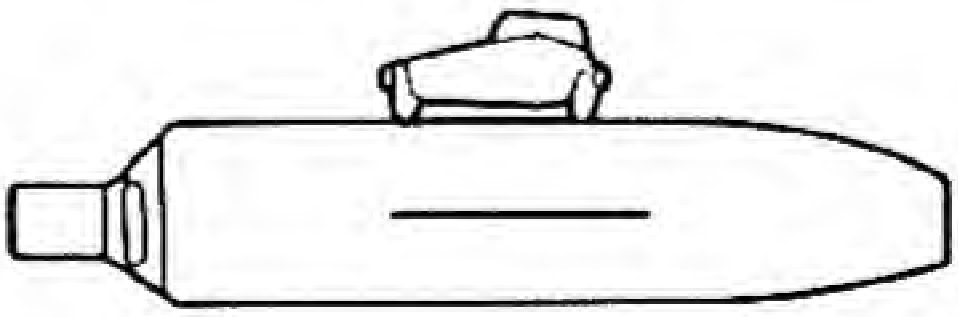
Caliber: 20mm U.S. Mk 100 Series
Rate of Fire: 4200 spm
Weight: 240 lb
Dimensions: 78.5"L x 10"W x 11"H
Date Developed: 1956
Number Produced: 1000



Mk 4 Gun Pod

Self-contained, self-powered external gun pod for U.S. Navy/Marine Corps fixed wing aircraft. Houses 20mm Mk 11 Gun.

Weight: 787 lb empty, 1390 lb loaded
Capacity: 750 round rotary magazine
Number Produced: 1000

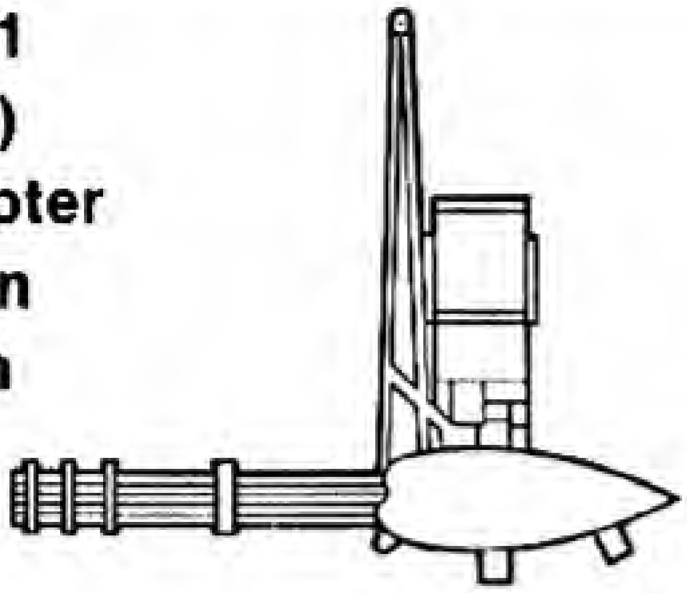


TOW Missile Pod

Lightweight, low-drag missile launcher for Model 500 Series Defender light helicopters. Has blast and debris diverter provisions.

Weight: 52 lb
Capacity: 2 missiles each pod
Number Produced: In Production

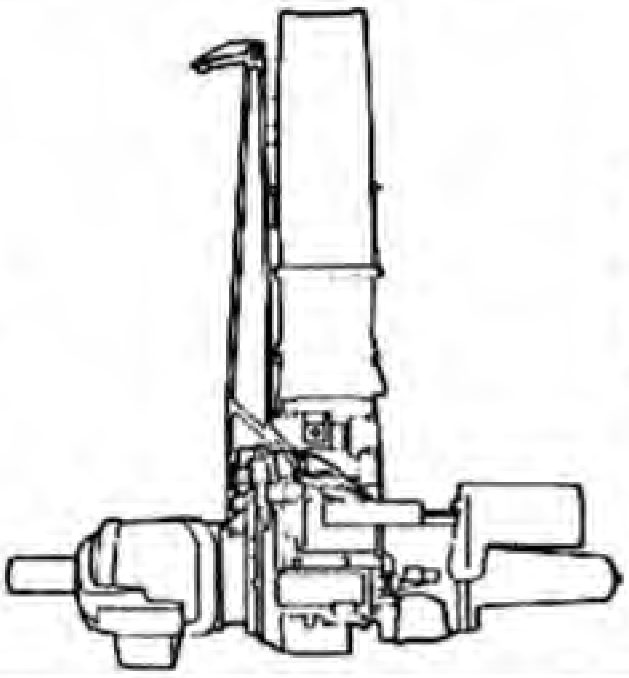
XM27E1 (HGS-5) Helicopter Weapon System



7.62mm gun system for light helicopters. Used on OH-6A during Vietnam conflict. Adaptable to Model 500 Series light attack helicopters. Uses M134 Minigun firing 2000 or 4000 spm.

Weight: 107 lb empty, 235 lb loaded
Capacity: 2000 round box magazine
Number Produced: 1000+

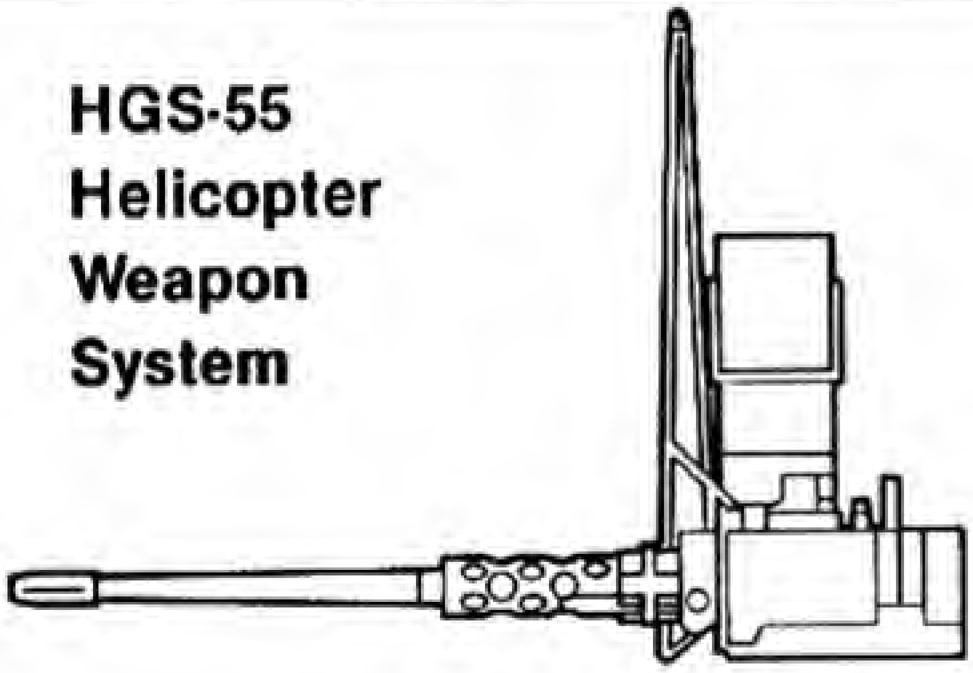
XM-8 Helicopter Weapon System



40mm grenade launcher system for light helicopters. Can be interchanged with HGS-5, HGS-55 and XM27E1 systems. Flexible (elevation only) mounting. Uses M129 High Velocity Grenade Launcher.

Weight: 120 lb empty, 238 lb loaded
Capacity: 150 round rotary magazine
Number Produced: 8

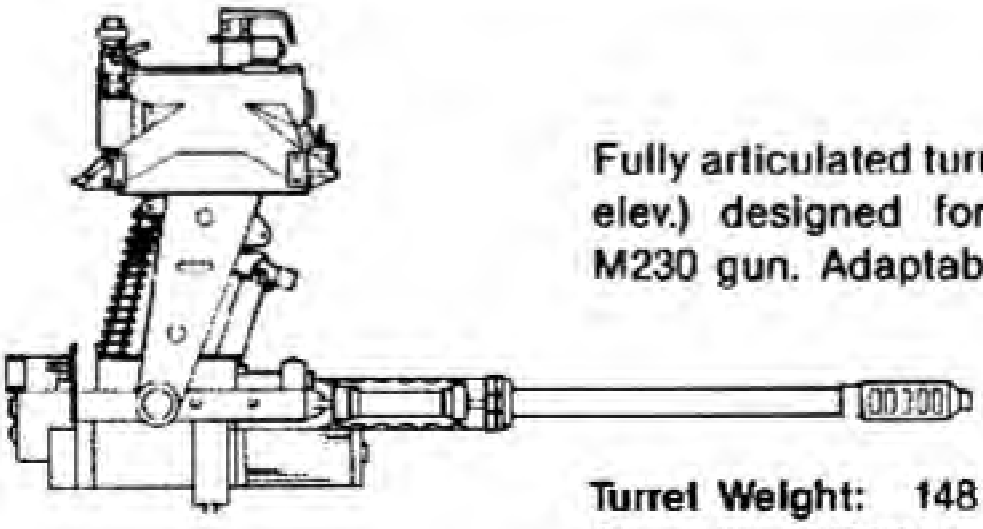
HGS-55 Helicopter Weapon System



7.62mm flexible (elevation only) gun system for light helicopters. Uses EX-34 gun. Similar to HGS-5 Helicopter Weapon System.

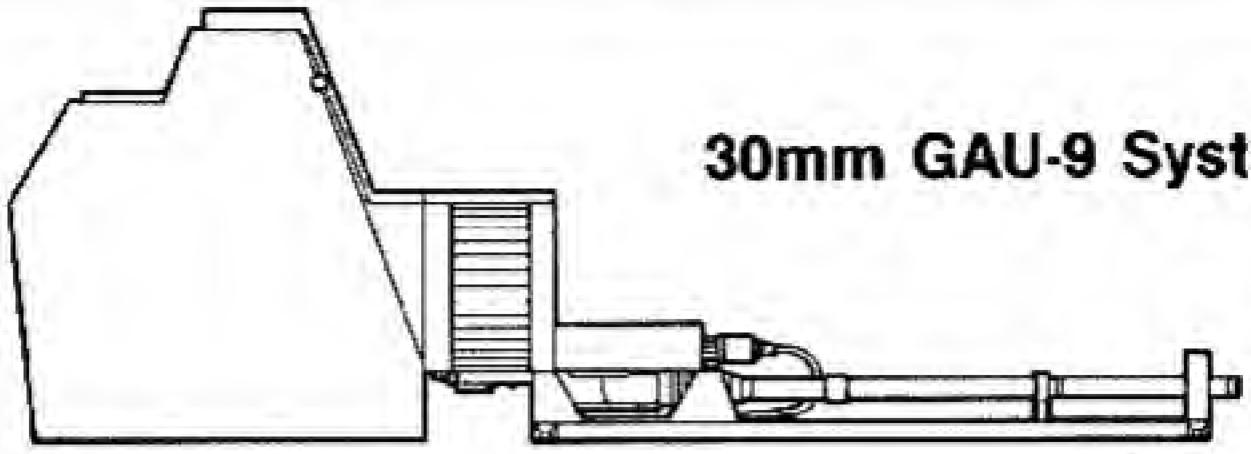
Weight: 90 lb empty, 218 lb loaded
Capacity: 2000 round box magazine
Number Produced: In Production

AH-64 Turret



Fully articulated turret (± 100°Az., + 11° - 60° elev.) designed for AH-64 helicopter and M230 gun. Adaptable to other installations.

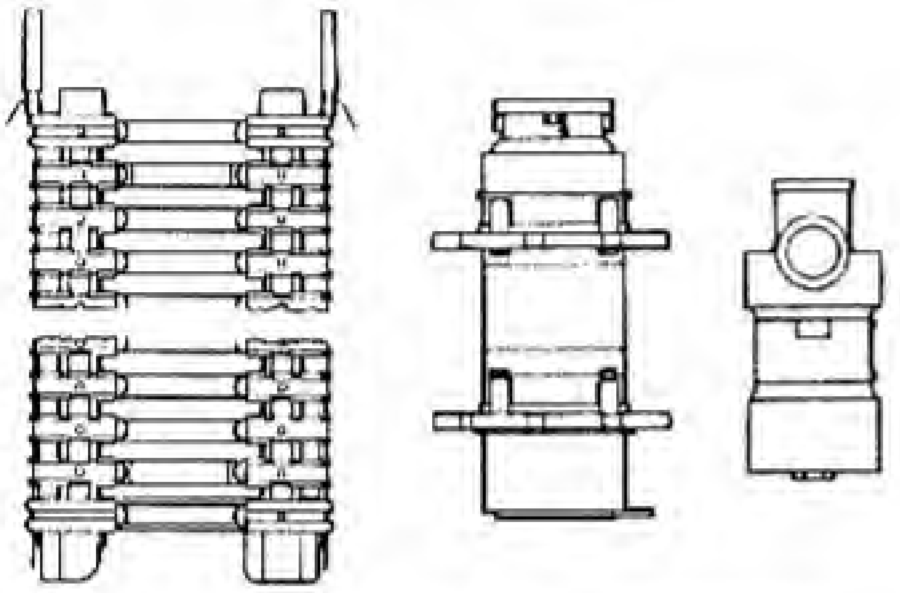
Turret Weight: 148 lb
Capacity: 1200 rounds in magazine
Number Produced: In Production



30mm GAU-9 System

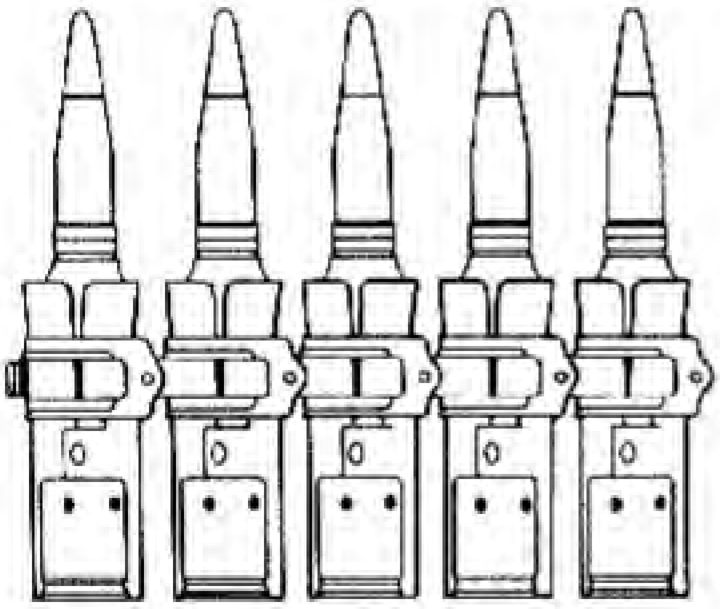
30mm self-powered internal two-gun system for A-10 aircraft. Used two Oerlikon KCA (GAU-9) cannons; 1350 spm each.

Weight: 1026 lb empty, 2277 lb loaded
Capacity: 750 rounds in two magazines
Number Produced: 2 Prototypes



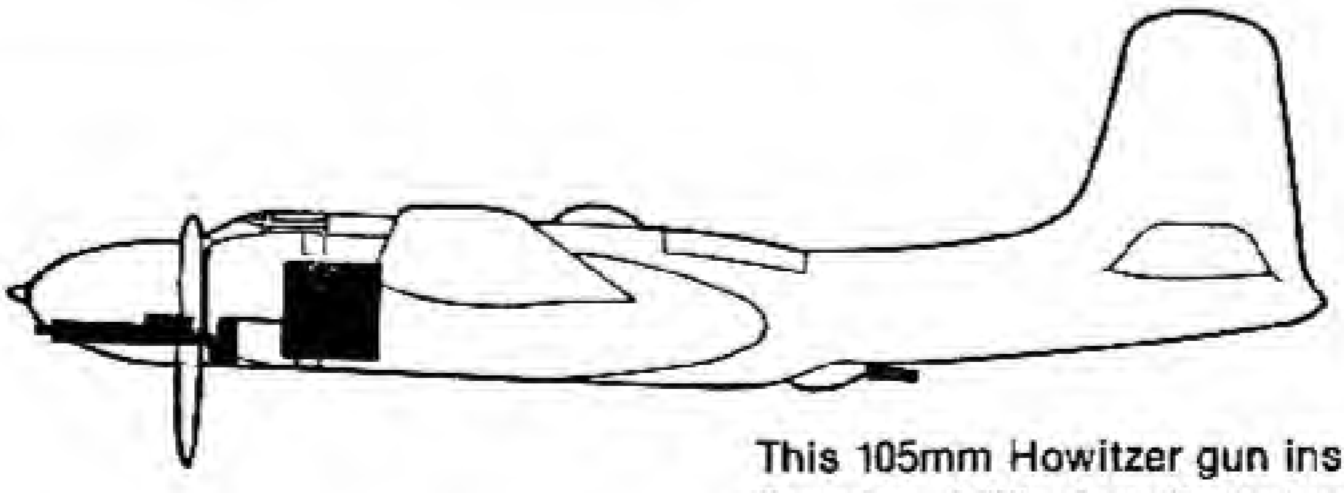
Chute, Boosters, Regulators

The company pioneered the development and production of flexible feed chute in the early 1940s. Later, the company developed boosters, air pressure regulators, and other accessories for use with gun systems. These items have been in continuous production for more than 40 years.



Ammunition and Links

The company is active in ammunition and link development to support its gun programs. Produced more than five million Mk 6 ammunition links for use with 20mm Mk 11 Gun System. Developed lockless, plastic encapsulated, telescoped cartridge. Directed 30mm ammunition development and qualification for the AH-64A Apache.



105mm Gun in A-26

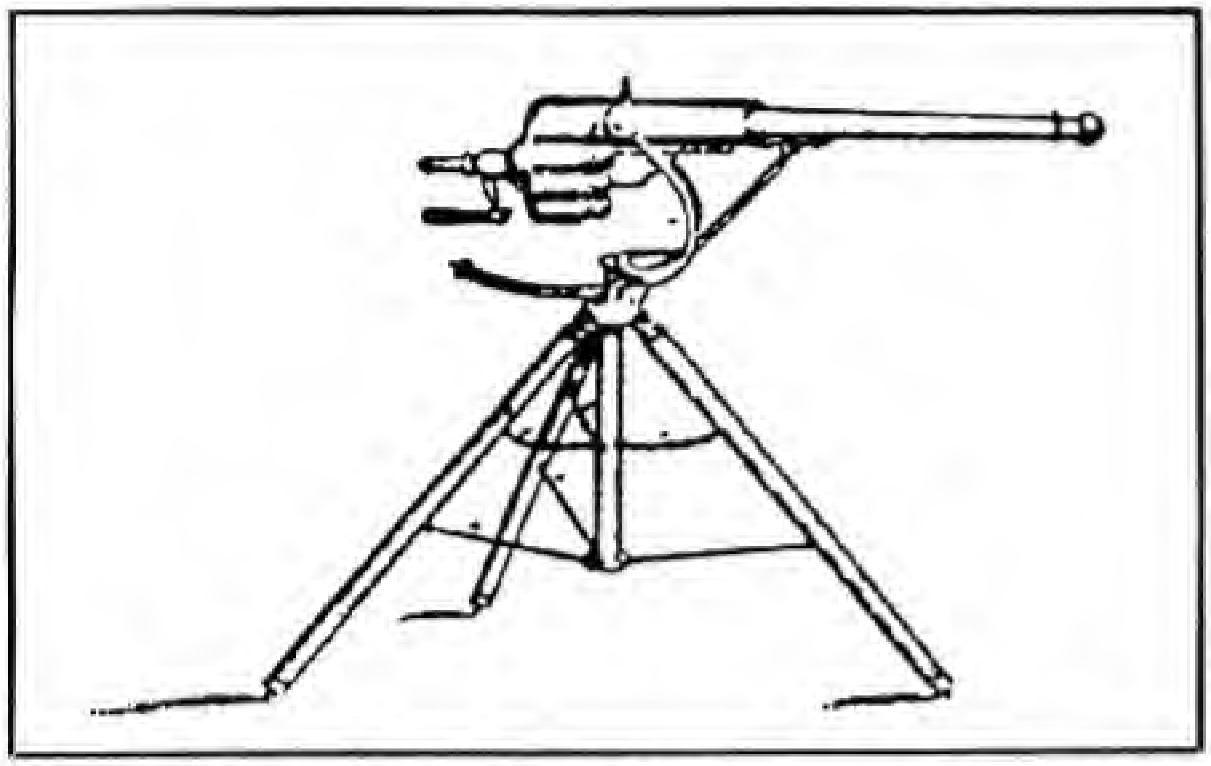
This 105mm Howitzer gun installation in the Douglas A-26 aircraft during World War II was the largest fixed, forward-firing gun installation ever flown.

PART XIV

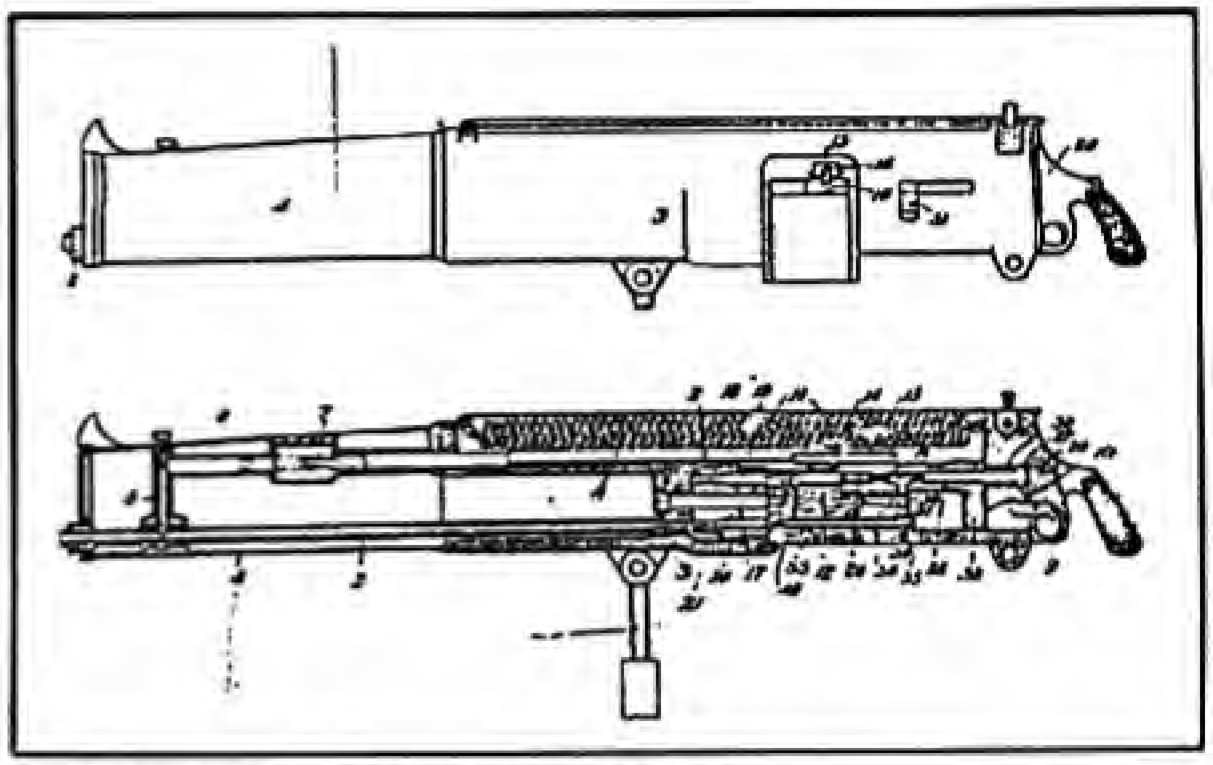
REVOLVER CANNONS

Chapter 45

THE REVOLVER CANNON



Revolver Cannon Invented by Mr. James Puckle in 1718

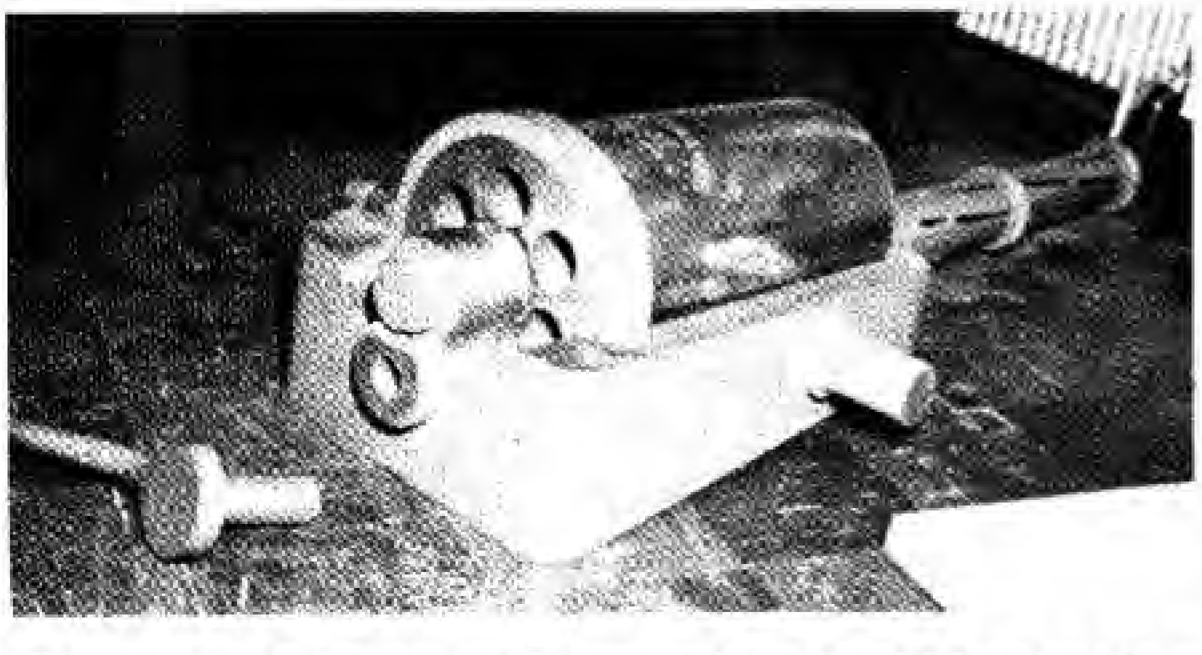


Rapid Fire Gun - C.M. Clarke, 1905

History

The story of the revolver cannon begins in England in 1718 with Mr. James Puckle. The device shown in a copy of the patent drawing had one especially interesting feature; it anticipated the requirement for two different ammunitions to be fired from the same gun. Mr. Puckle suggested in the patent that the cannon be loaded with square bullets for the infidel and round bullets for Christians.

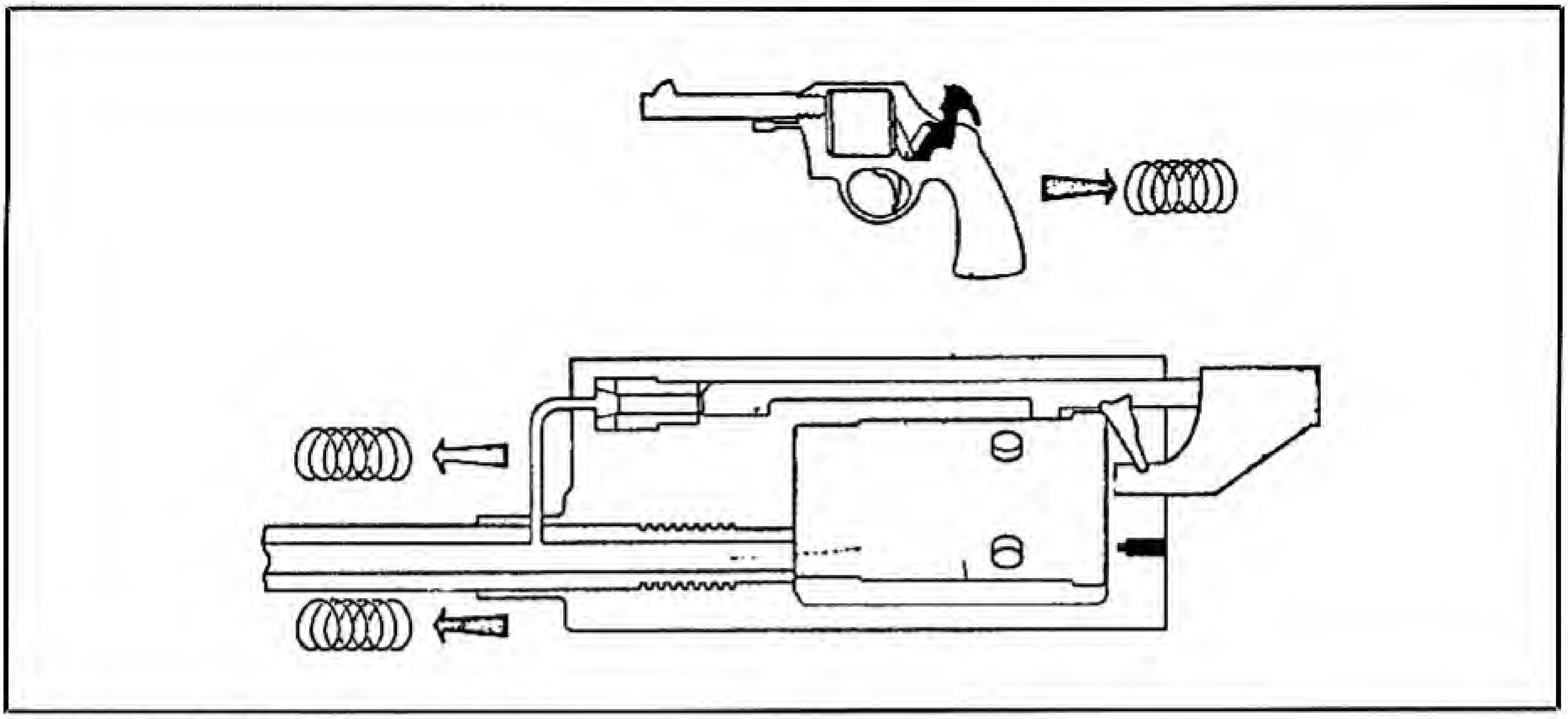
The next historical occurence of the revolver as a cannon came in 1861. The DeBrame cannon was interesting in the sense that the basic layout and components exactly duplicated the modern revolver cannon. Mr. DeBrame's gun was not automatic loading and had to have the rounds both loaded and extracted by hand; however, the breeching mechanism did provide a model for later efforts.



The American DeBrame Cannon of the Civil War Era. This weapon is hand operated and resembles modern, gas-operated revolver cannon.

The first gas operated revolver cannon came into the United States in 1905. This era was the heyday of machine gun inventors and everyone who fancied himself a gun inventor had invented at least one machine gun. The Clarke gun used the same principles used today in that the cylinder was rotated by a gas operating slide. The gas for the operation being tapped off the barrel in a way used many, many times since.

The recent history of the revolver cannon began in Germany during World War II. The German high command developed a requirement for a "million point gun," that is, a thousand shots per minute with a velocity of a thousand meters per second to arm the ME262 airplane. It ws recognized even then that jets with their higher closing speeds were going to need a high rate gun to provide optimum kill capabilities, so the 1,000 spm requirement was set for this aircraft. The sporting arms firm of Krieghoff had such a gun



Sketch of Revolver and Frame

in 20mm which was known as the MG-301. The German high command, at the insistence of World War I ace, Ernst Udet, felt that the Krieghoff firm had neither the facilities nor the background to develop an aircraft cannon and moved the development to Mauser, where the gun was renumbered MG-213A. This gun was not a revolver cannon; it was a reciprocating type gun. The MG-213A design was passed on to the designers in the Mauser design group. It's interesting from the standpoint of what has happened to later revolver cannon developments to look at the makeup of this group. The two principal designers associated with the project were Mr. A. Politzer and Mr. Werner Jungemann. As in any design group, it is quite clear that while these people may have been the principals, there were many, many others behind them. As a result, many different people could be called the designers of the modern revolver cannon. The Project Engineer was Mr. Linder and the Joint Managing Director was none other than Otto Von Lossnitzer.

The 213A would not come up to rate although the ammunition performance was quite impressive, so Mr. Linder proposed a variation (still a reciprocating gun) called the MG-213B. Some analysis was done on this and it was decided that the gun still would not achieve the required rate. At that point the revolver cannon design, which was identified as Mr. Politzer's version and the MG-213C, was proposed. The 213C showed sufficient promises so that development begin first in design and then in hardware. A prototype gun and five others were built at Mauser.

To really understand the operating principle of a revolver cannon, it's probably easiest to compare the cannon to an ordinary revolver pistol. In the revolver pistol, four basic components are required; a barrel, a

MILLION POINT GUN

1000 SHOTS/MIN AT 1000 M/SEC

KRIEGHOFF / MG 301

MAUSER / MG213A

LINDER'S VERSION / MG213B

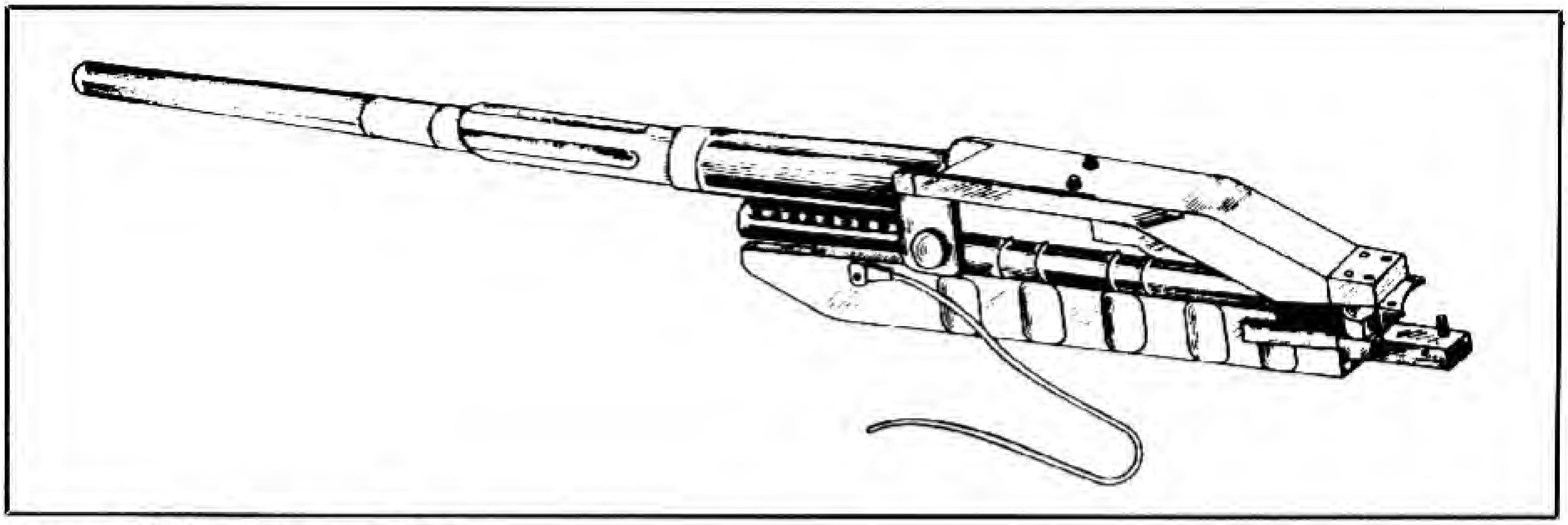
POLITZER'S VERSION / MG213C

MAUSER DESIGN GROUP

DIRECTOR / OTTO VON LOSSNITZER

PROJECT ENGINEER / FREDRICK LINDER

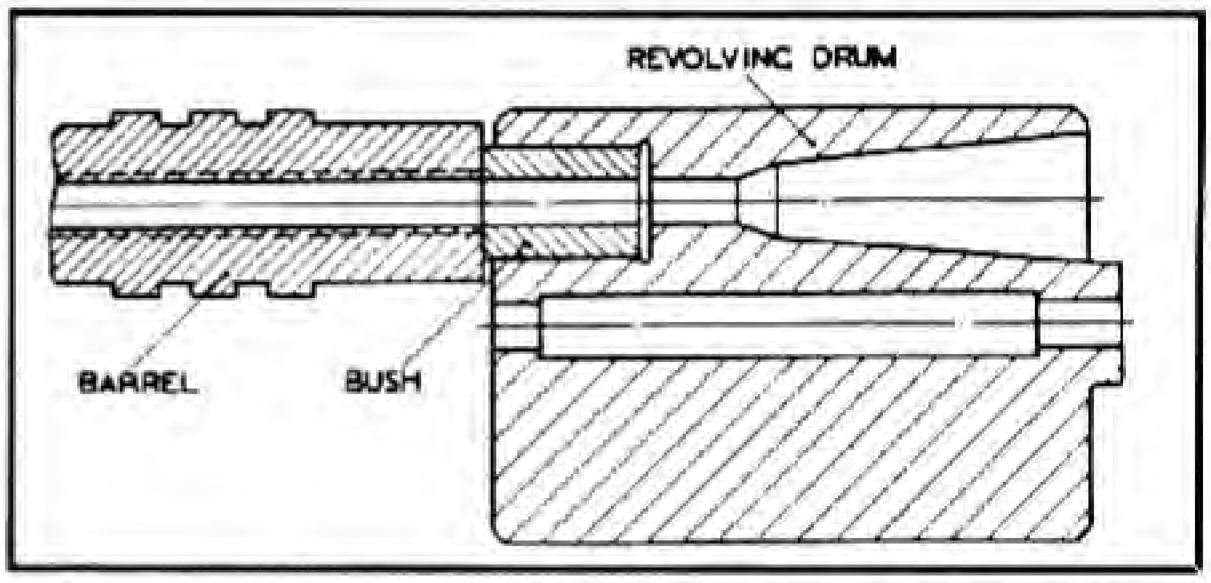
DESIGNERS / ANTON POLITZER
WERNER JUNGEMANN



German MG-213. Right Front View.

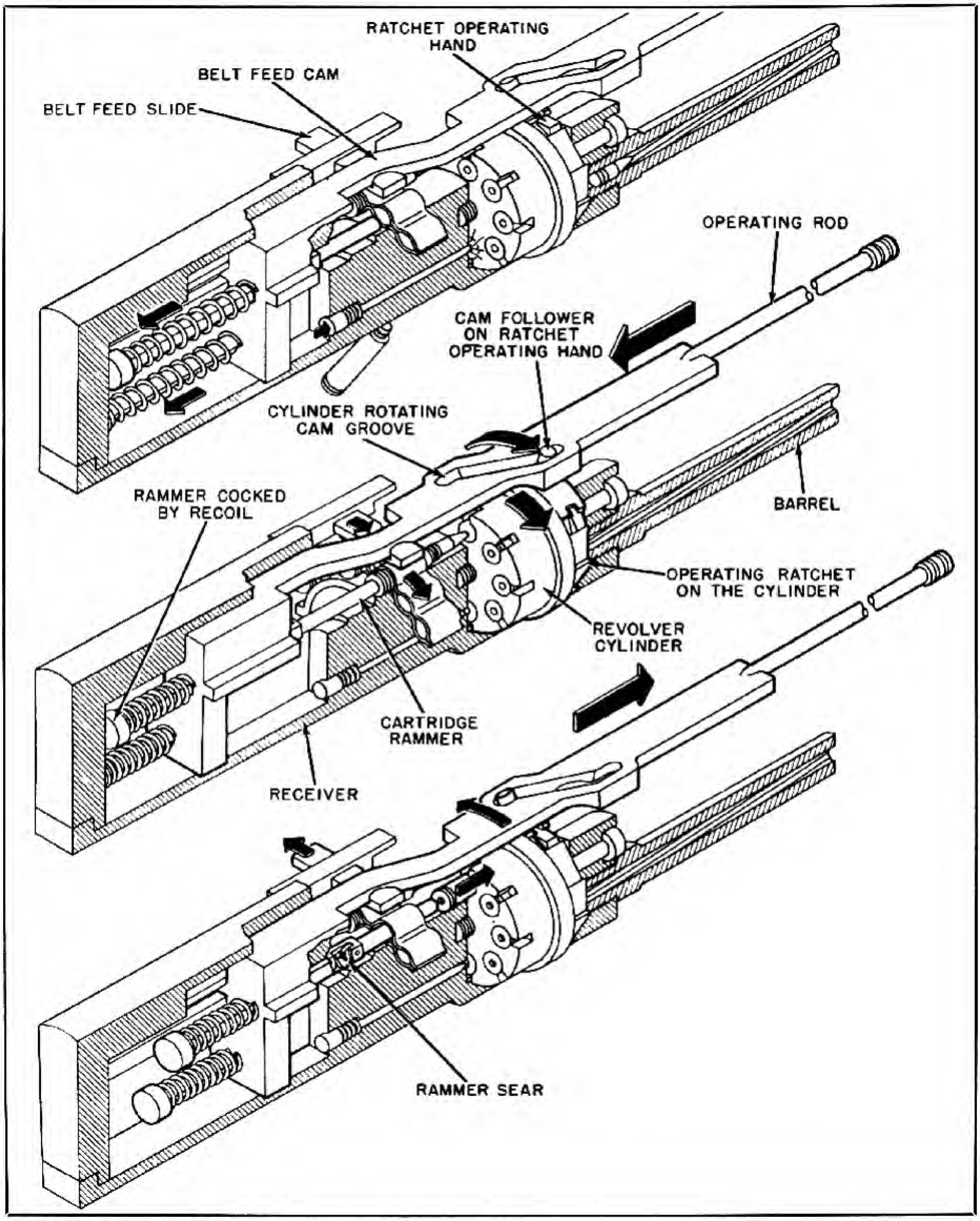
frame to support the barrel and provide a locking surface behind the revolver, the revolver cylinder itself, and a means of rotating the revolver cylinder after each shot. With the revolver cannon these same elements are present, the barrel, frame, and revolver cylinder. The mechanism for rotating the revolver cylinder changes to an operating slide which is driven by a gas piston obtaining its energy from a gas tap in the barrel. Two other features are added — a rammer and an extractor which load and unload respectively live rounds and fired cases from the gun.

After the war the design group at Mauser was faced with the prospect of being captured either by the Western powers or by the Russians. The designers involved in the 213 group all opted to be "captured" by the West. Werner Jungemann went to England in 1949 taking with him some MG-213C drawings which were converted to English dimensions most nearly like Mk 213/30. This version became the Aden Gun. Anton Politzer went to DEFA in 1948, hired 40 to 50 people to form the DEFA revolver cannon design group. The success of that effort is still visible today. Fredrick Linder moved to Oerlikon in 1947 where he began work on the 302RK which was a 30mm version firing the round that is very similar to today's AX round. The 302 was still a five chambered gun with a cradle. In about 1952, development and early design studies began on the 304RK, a follow-on generation to the 302. The 304 differed from the 302 in two important respects; one was that the cradle was eliminated and

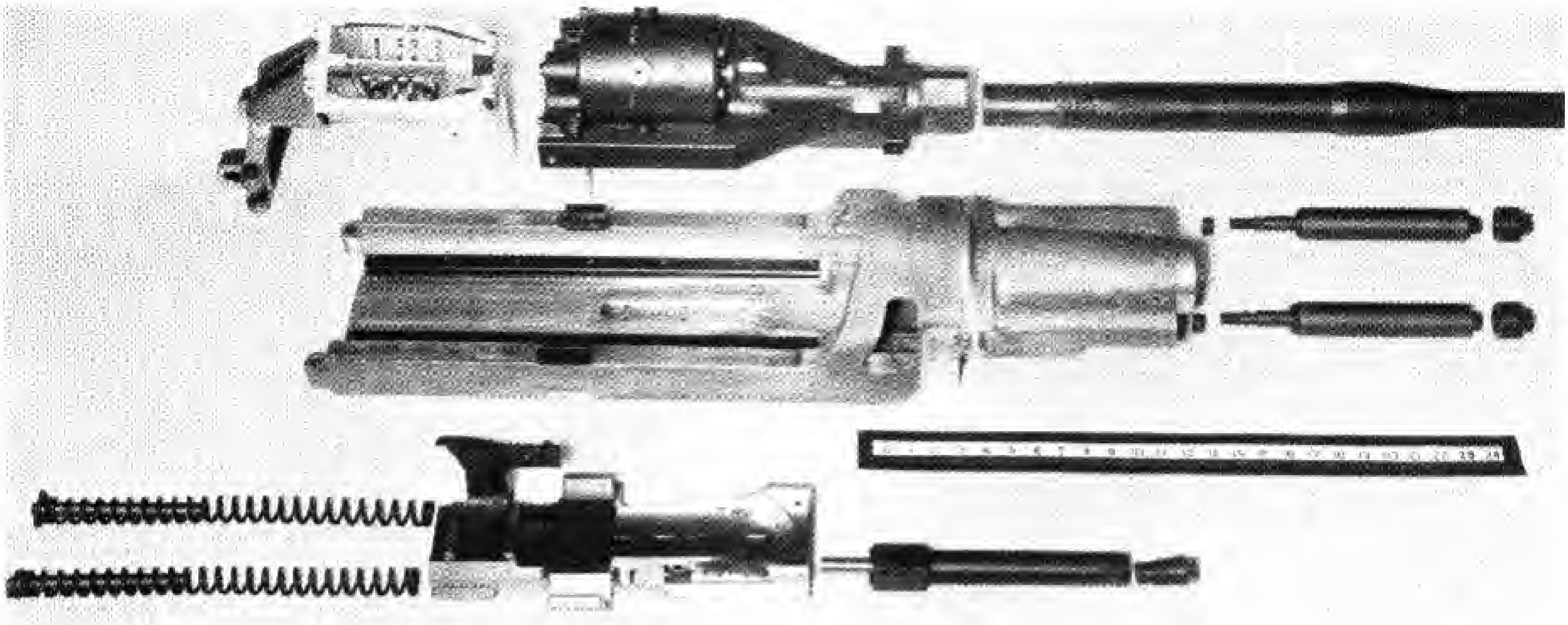


Diagrammatic Assembly of Revolving Drum for MG-213C

Mk 213 Revolver Cannon


RATCHET OPERATING HAND
BELT FEED CAM
BELT FEED SLIDE
OPERATING ROD
CAM FOLLOWER ON RATCHET OPERATING HAND
CYLINDER ROTATING CAM GROOVE
BARREL
RAMMER COCKED BY RECOIL
OPERATING RATCHET ON THE CYLINDER
REVOLVER CYLINDER
CARTRIDGE RAMMER
RECEIVER
RAMMER SEAR

Simplified Schematic of a Typical Gas-Operated Rotary Action Cannon



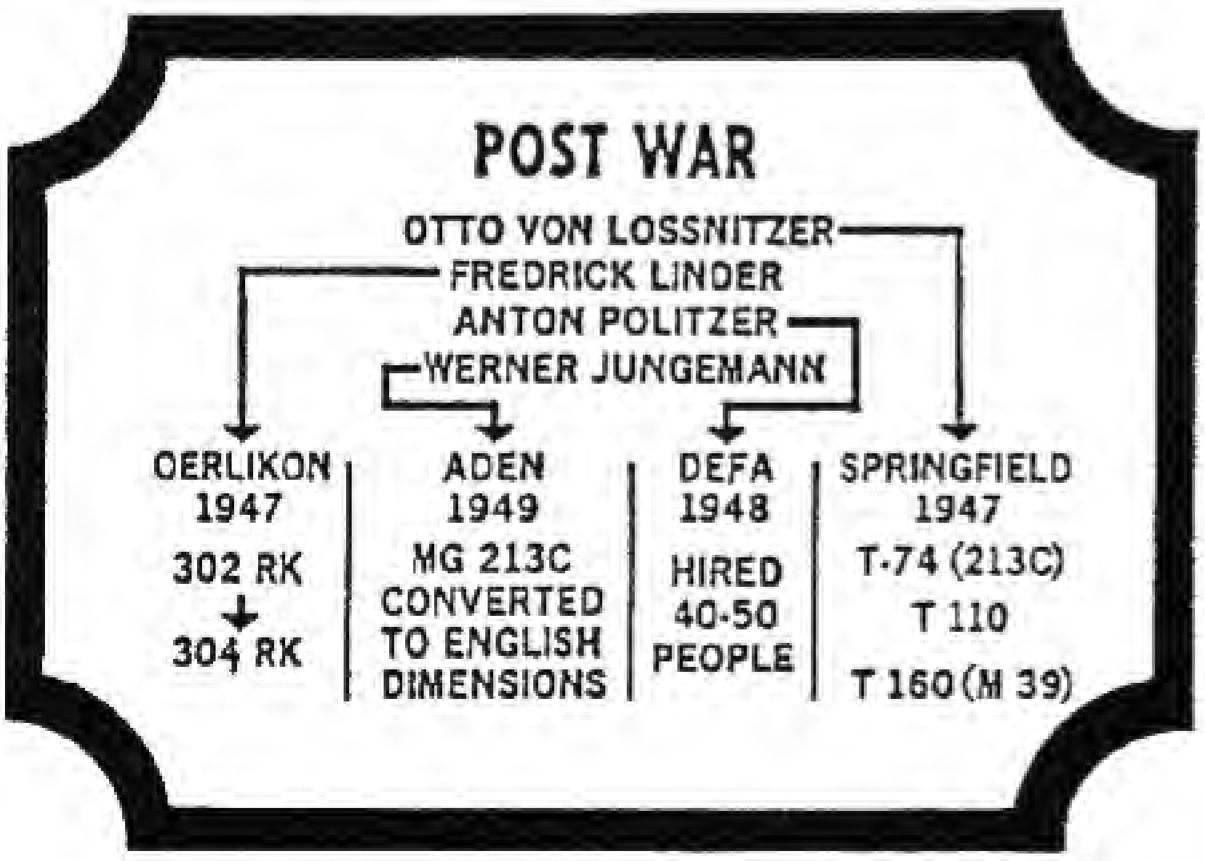
Typical Revolver Gun

the entire gun except for the mounting flange was allowed to recoil. The gun was also lightened and made more compact by reducing the revolver cylinder to four chambers instead of five.

To complete the post-war picture, Otto went to Springfield in 1947 where a captured 213C, rebuilt by the Naval gun factory, was renumbered T-74. The T-74 progressed in 20mm through the T-110 and the T-160 which was type classified as the M-39. There were also several 30mm versions of the MG-213C-type gun studied and built at Springfield in the same time period.

Cycle of Operation

The gas cylinder which contains the piston for actuating the slide forms an integral part of the drum support. This arrangement permits bleeding gas from the tube through a straight passage leading directly from the tube into the gas cylinder. Since the gas cylinder is a part of the recoiling mass, the force exerted by the gas piston on the slide opposes the recoil force and reduces the load on the recoil springs by an amount dependent upon the size of the gas orifices.

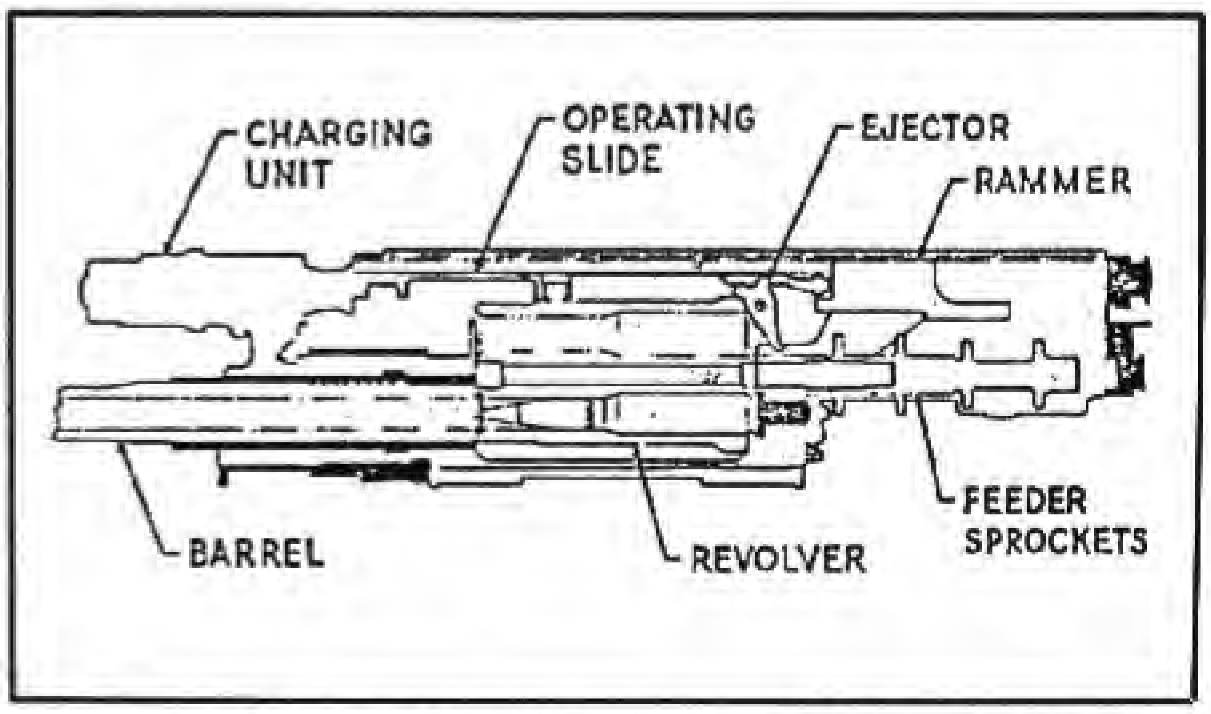


POST WAR
OTTO VON LOSSNITZER
FREDRICK LINDER
ANTON POLITZER
WERNER JUNGEMANN
OERLIKON 1947
302 RK
304 RK
ADEN 1949
MG 213C CONVERTED TO ENGLISH DIMENSIONS
DEFA 1948
HIRED 40-50 PEOPLE
SPRINGFIELD 1947
T-74 (213C)
T 110
T 160 (M 39)

Leakage of gas from the tube gas port between the tube and the mating bore of the drum support has been minimized by machining six labyrinth grooves in the tube, three on each side of the gas port.

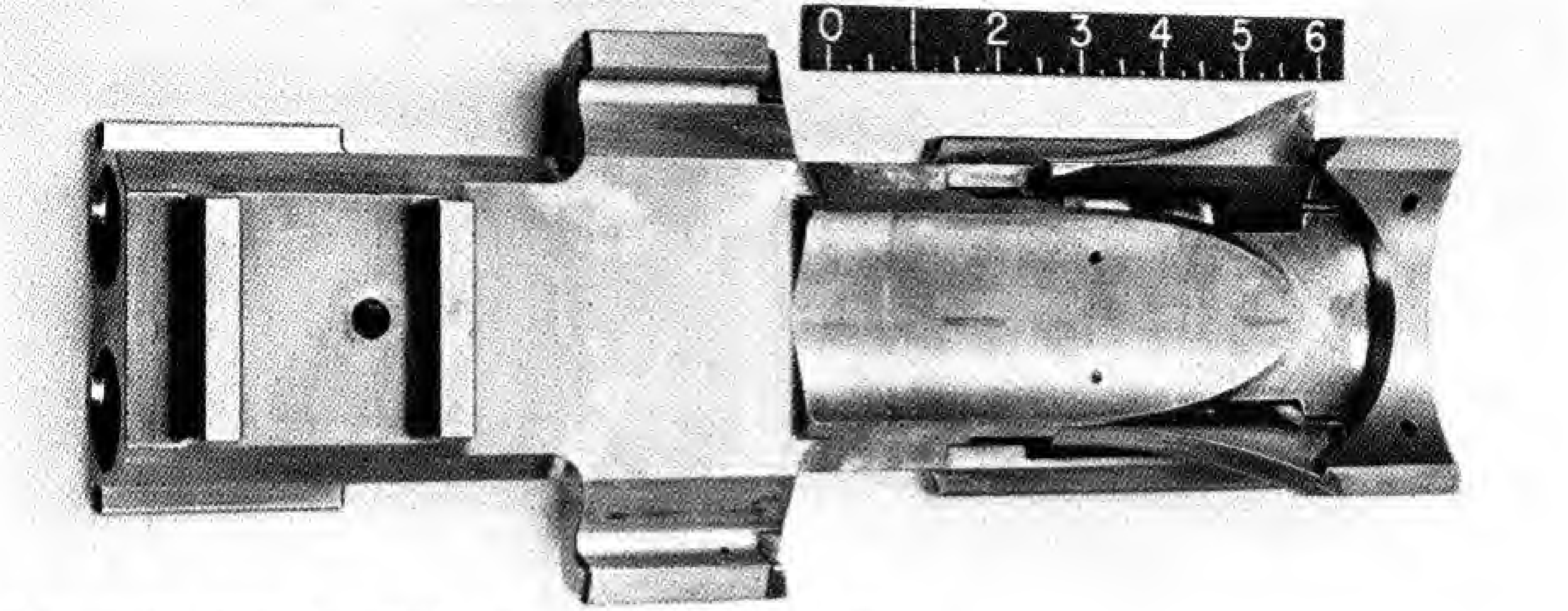
Leakage of gas past the gas piston is prevented by three labyrinth grooves around the piston.

The rear end of the drum support houses the firing pin assembly which serves as the anvil for supporting the case during firing. The firing pin assembly has been made small in diameter in order to provide for maximum strength in the rear end of the drum



CHARGING UNIT
OPERATING SLIDE
EJECTOR
RAMMER
BARREL
REVOLVER
FEEDER SPROCKETS

Schematic Showing Major Components of Revolver Cannon



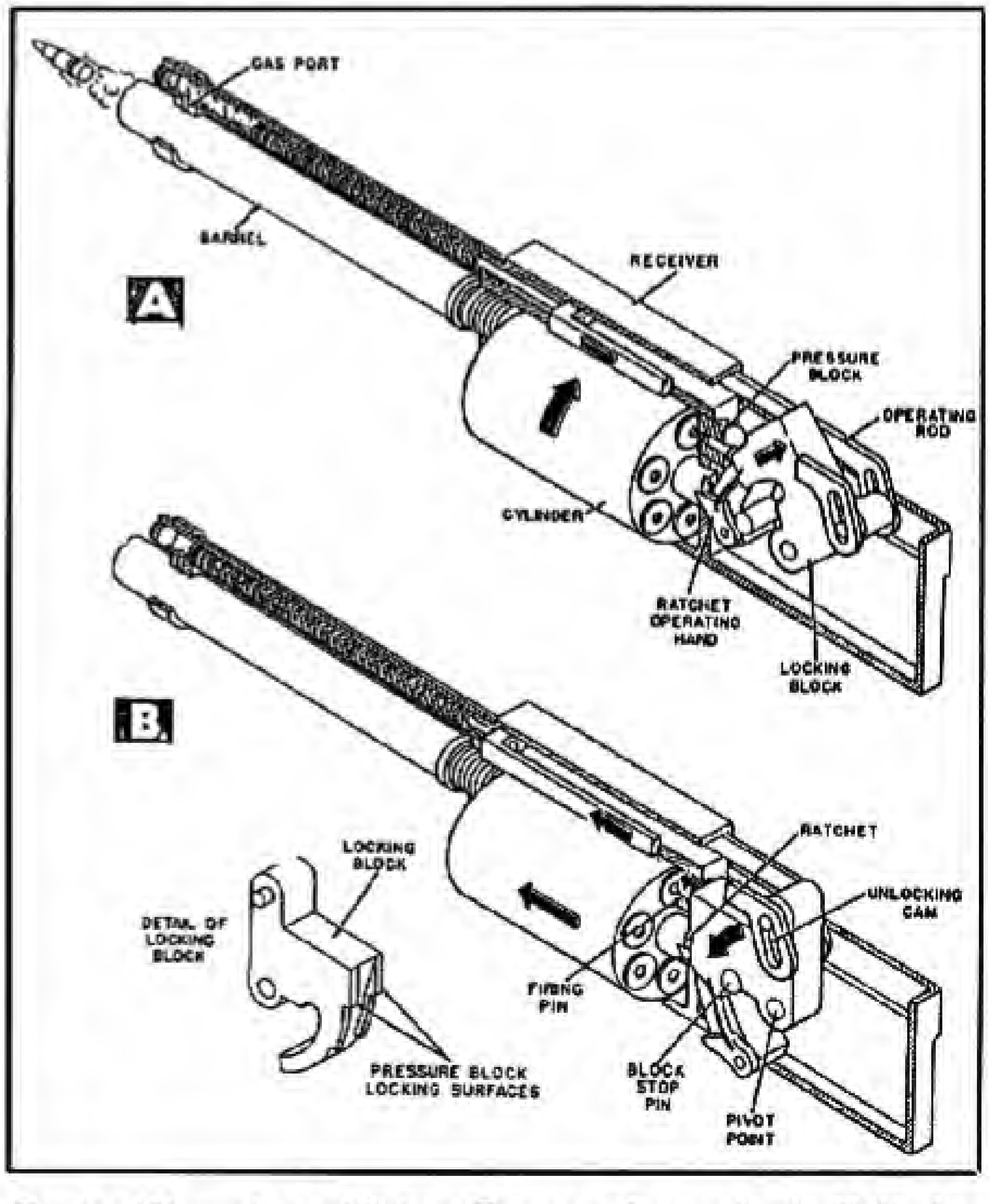
Automatic Gun, Calibre .60 T130 Revolver Actuating Slide Assembly

support. This strength is necessary because of the concentrated load imposed on the drum support by the gas pressure acting on the cartridge case and the distributed load imposed by the gas pressure acting on the bottom of the sealing sleeve recess in the drum.

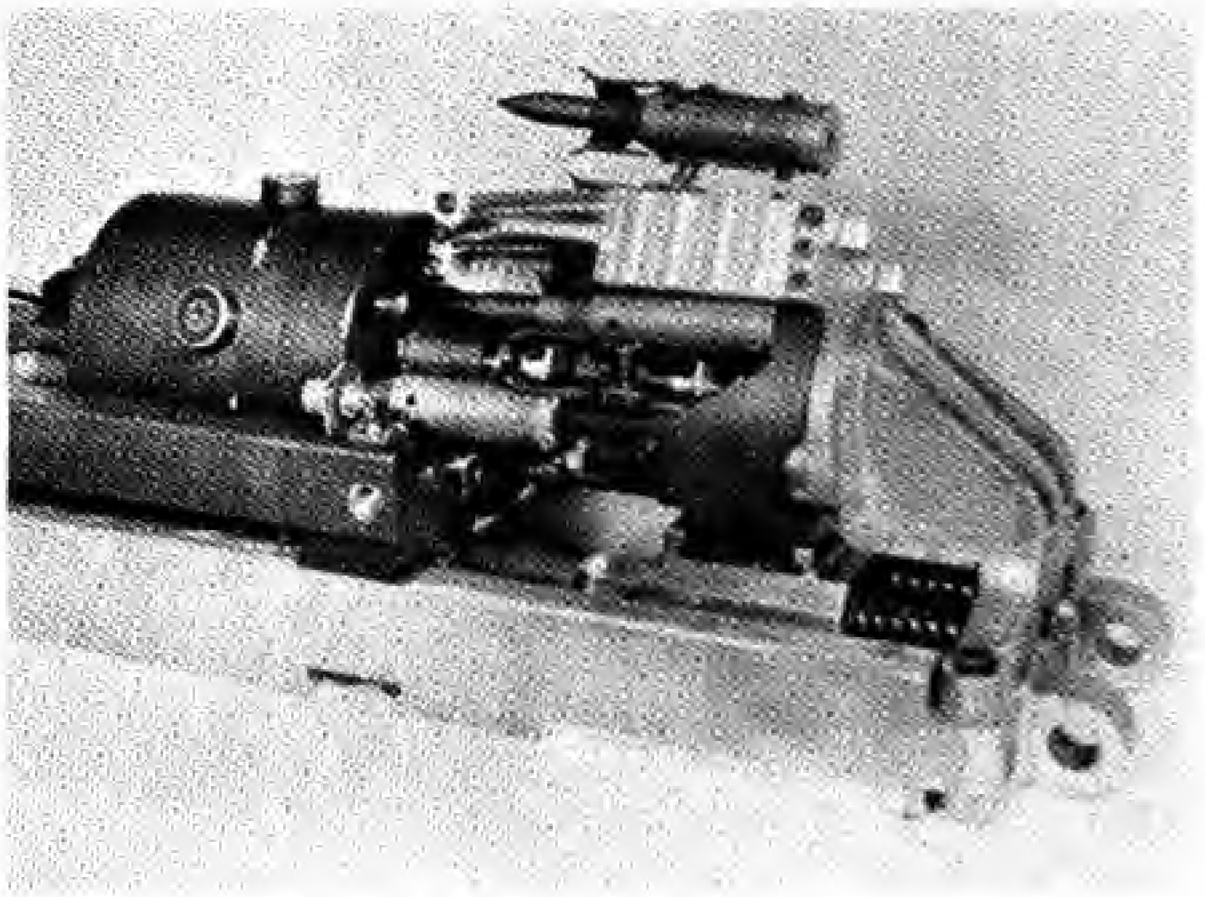
The drum is machined from a forged steel billet. It contains equally spaced chambers, with a gas sealing sleeve at the front of each chamber. Sealing against gas leakage between the sleeve and the sleeve recess in the drum is accomplished by grooves around the sleeve, and by longitudinal grooves around the rear end of the sleeve at 90° spaced intervals. Gas pressure acting on the rear end of the sleeve forces the sleeve out against the face of the tube and prevents serious leakage of gas between the end of the sleeve and the face of the tube during firing. Around the periphery of the drum and radial with the chambers are rollers mounted on studs and retained by blind snap rings. The studs are integral with the drum, thus providing adequate strength in the outside chamber walls.

The drum is mounted upon a shaft supported in the drum support and is keyed to it by dogs machined on the rear end of the shaft. The shaft rotates with the drum and causes the feeder shaft to rotate with it by means of a universal joint connecting the two. This universal joint corrects any misalignment caused by deflections during firing. A spring-loaded latch pin in the front end of the drum support engages a groove in the end of the drum shaft to prevent axial motion.

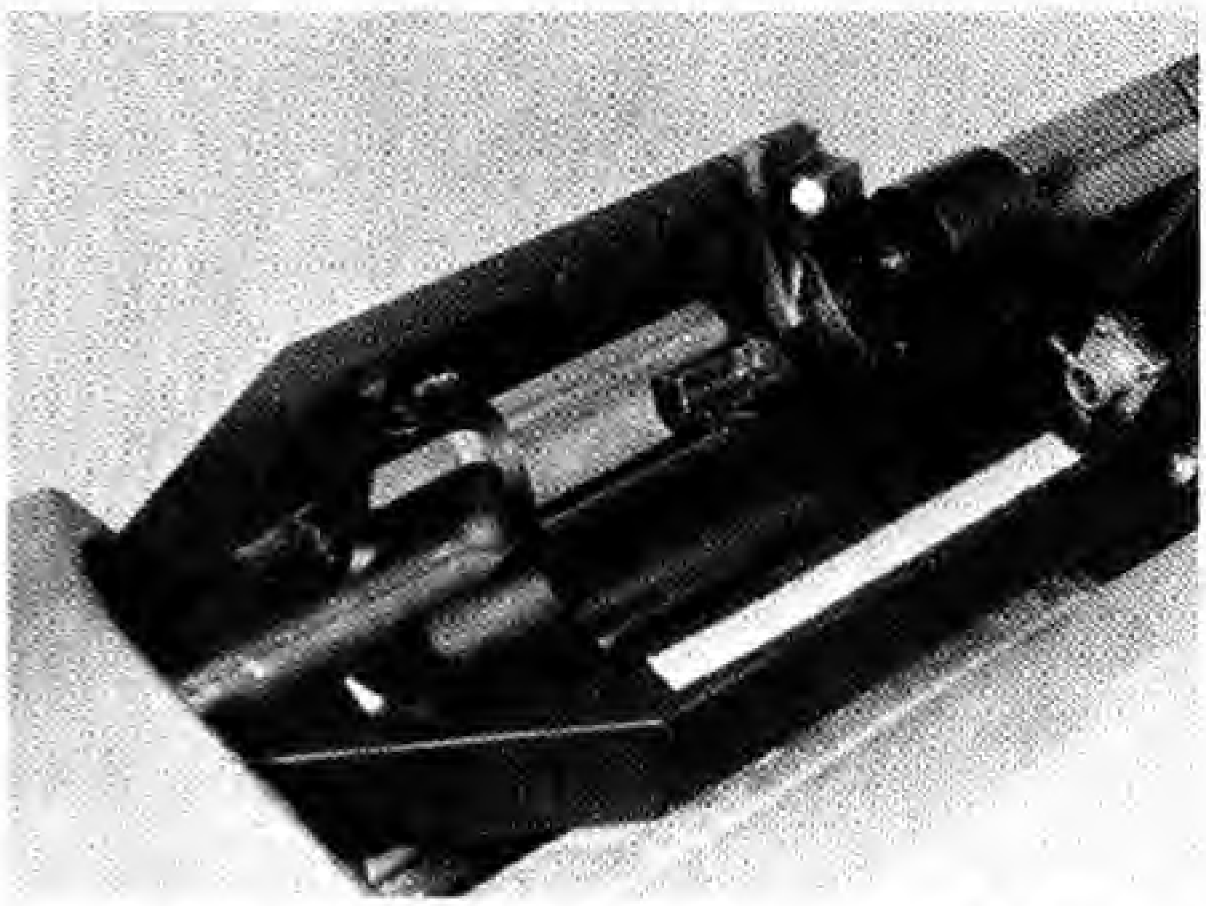
The actuating slide fits in guideways in the bottom of the receiver and moves backward and forward beneath the drum and drum support under the action of the gas piston and the drive springs. Machined into the slide are two cam paths which engage the drum rollers and cause the drum to rotate as the slide moves through its cycle. A part of the inside edge of each cam path is formed by a movable member, called the


GAS PORT
BARREL
RECEIVER
A
PRESSURE BLOCK
OPERATING ROD
CYLINDER
RATCHET OPERATING HAND
LOCKING BLOCK
B
RATCHET
LOCKING BLOCK
DETAIL OF LOCKING BLOCK
UNLOCKING CAM
FIRING PIN
PRESSURE BLOCK LOCKING SURFACES
BLOCK STOP PIN
PIVOT POINT

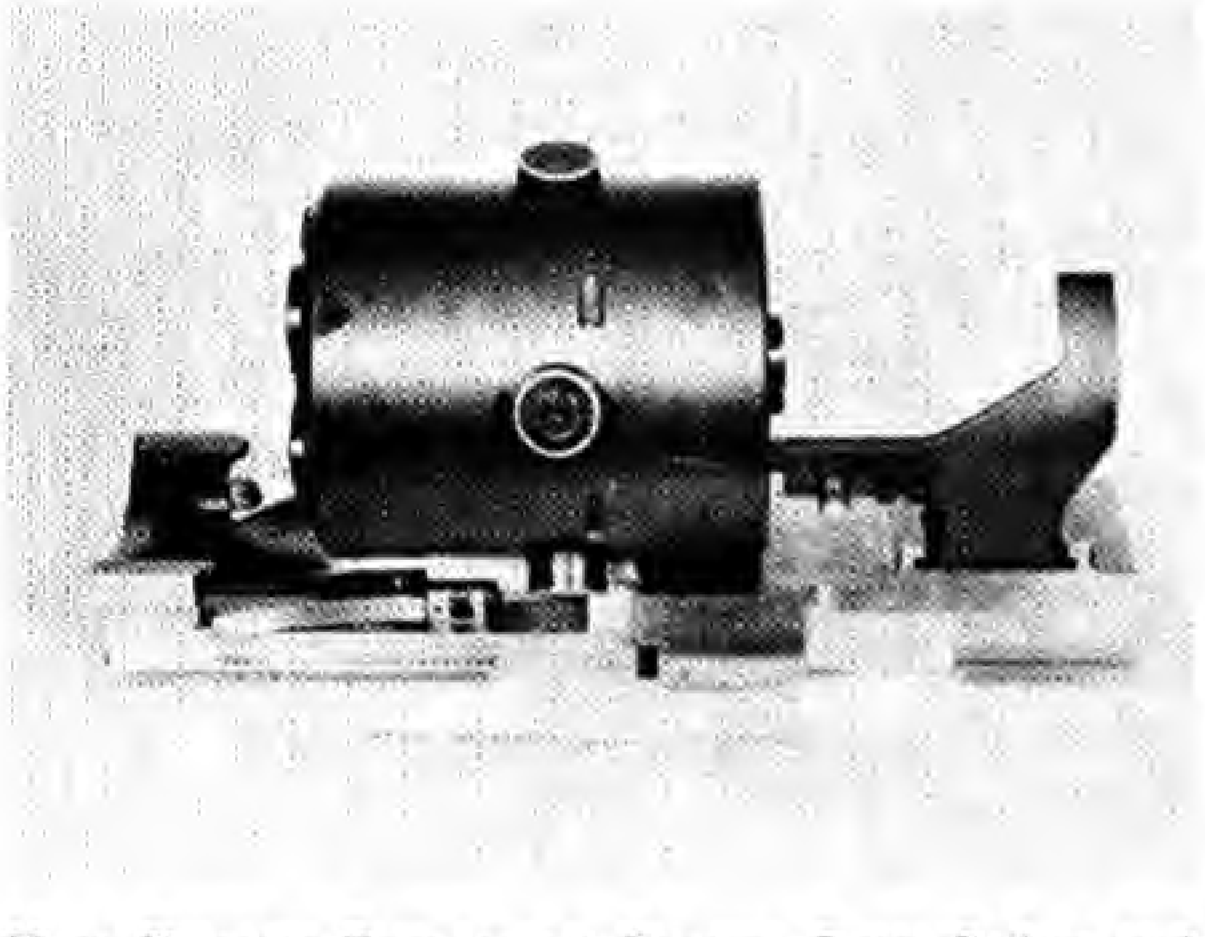
Cycle of Operation of Rotary Cannon. Action Locks Cylinder to Barrel.



View Showing Start of Ramming Stroke



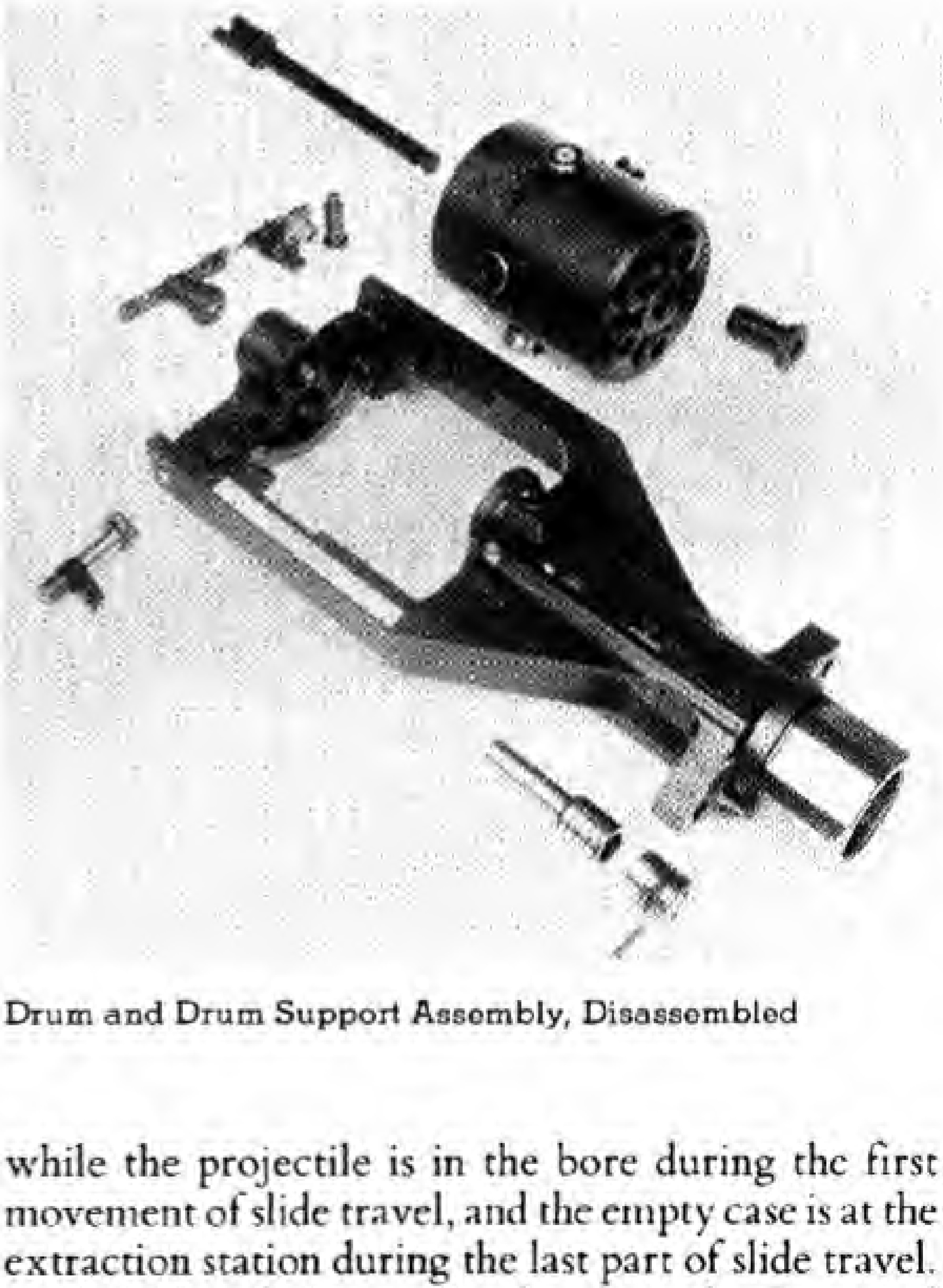
View Showing Extractor Striker on Slide, and Extractor (drum removed)



View Showing Engagement Between Drum Rollers and Actuating Slide (slide forward)

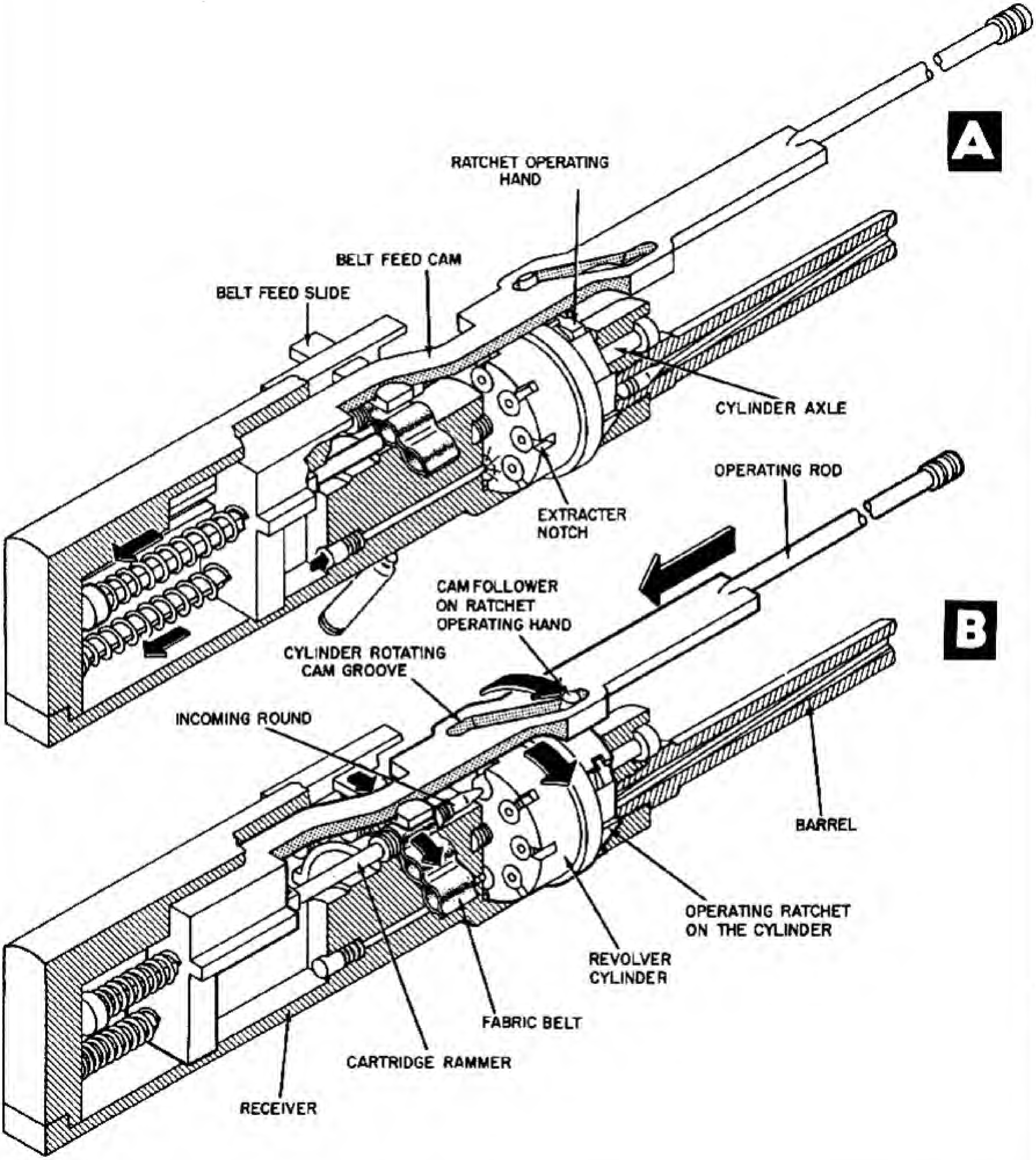
switch tongue, which pivots about its forward end. The position of this switch tongue determines which cam path is made continuous throughout its length.

Underneath the slide is a cam which engages a stud on the switch tongue or a spring-loaded pin within the stud. This cam is designed so as to cause the switch tongue to move from one side to the other at the proper time in the cycle, thus changing the continuity of the cam path in the slide from one side to the other and causing the drum to move in one direction on both the rearward and forward stroke of the slide. The straight portion of the slide cam keeps the drum stationary for the first two inches of the rearward travel. Thus the chamber is aligned with the barrel while the projectile is in the bore during the first movement of slide travel, and the empty case is at the extraction station during the last part of slide travel.

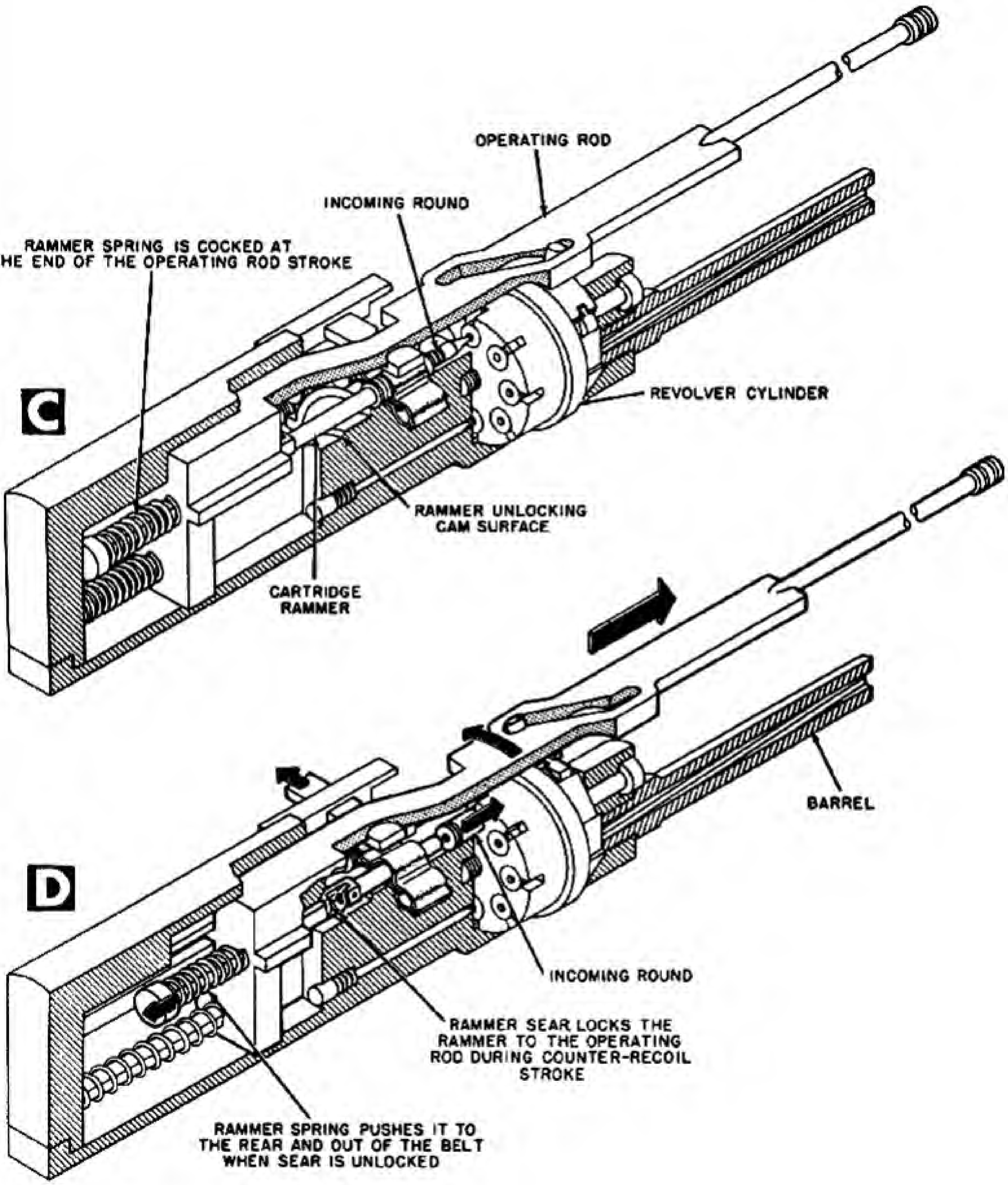


Drum and Drum Support Assembly, Disassembled

Variable relative motion between the drum and switch cam from round to round cannot be tolerated, as the switch tongue must be switched precisely at the proper position of the drum roller in the cam path. Therefore, since the drum is a recoiling part, and since the recoil cycle does not follow a consistent


A
RATCHET OPERATING HAND
BELT FEED CAM
BELT FEED SLIDE
CYLINDER AXLE
OPERATING ROD
EXTRACTER NOTCH
CAM FOLLOWER ON RATCHET OPERATING HAND
B
CYLINDER ROTATING CAM GROOVE
INCOMING ROUND
BARREL
OPERATING RATCHET ON THE CYLINDER
REVOLVER CYLINDER
FABRIC BELT
CARTRIDGE RAMMER
RECEIVER

Operating Cycle of Gas-Actuated Single-Barrel Rotary Cannon


C
OPERATING ROD
INCOMING ROUND
RAMMER SPRING IS COCKED AT THE END OF THE OPERATING ROD STROKE
REVOLVER CYLINDER
RAMMER UNLOCKING CAM SURFACE
CARTRIDGE RAMMER
D
BARREL
INCOMING ROUND
RAMMER SEAR LOCKS THE RAMMER TO THE OPERATING ROD DURING COUNTER-RECOIL STROKE
RAMMER SPRING PUSHES IT TO THE REAR AND OUT OF THE BELT WHEN SEAR IS UNLOCKED

Operating Cycle of Gas-Actuated Single-Barrel Rotary Cannon pattern, it was necessary to make the switch cam a recoiling part. This was done by machining a groove around the outside of the gas cylinder on the drum support to engage ears machined in the front end of the switch cam. The guide plate, attached to the bottom of the receiver, guides the cam during its recoil travel.

In addition to actuating the drum, the slide actuates the extractor and carries the rammer which rams the rounds from the links and chambers them.

The extractor, located in the rear of the drum support, is kinetically one piece. It consists of a shaft with a striker face on its lower end and an extractor pawl on its upper end.

As the slide returns to battery, a striker housed in a lug on the right side of the slide strikes a face on the lower end of the shaft, causing the shaft to rotate and allowing the slide to continue to battery. The extractor pawl is held in a retracted position after extracting the case, until the slide moves rearward again. When the lug engages the slide it clears the end of the extractor shaft, a torsion spring on the upper end of the extractor shaft returns the extractor to extraction position with the pawl against the face of the drum. The torsion spring returns the extractor with sufficient force to cause the pawl to bounce rearward from the face of the drum and to miss frequently the rim groove of the oncoming case to be extracted. Therefore, an antibounce device was incorporated in the extractor to reduce the amount of bounce and prevent failure to extract.

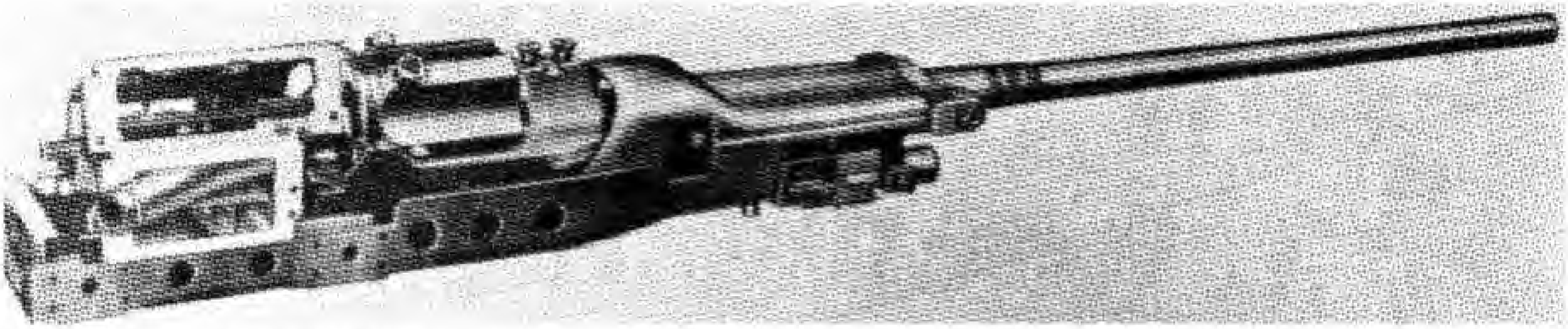
This device consists of a spring-loaded detent housed in the drum support which engages a shallow hole in the hub of the extractor pawl when the pawl is against the face of the drum. The ratio of movement of the end of the extractor pawl to the movement of the point struck by the slide is approximately 1.67 to 1. Case extraction velocities are of the order of 80 feet per second.

The rammer consists of a single piece mounted in guide slots at the rear end of the slide and held in place with a cap screw. For right-hand feed, the rammer curves outward to the left to clear the feeder sprocket and the edges of the open-sided links presented to the rammer by the feeder. The two slide-drive springs are of stranded wire construction. They engage holes in the rear end of the slide and are held in position at the rear by guide rods which engage bayonet locks in the receiver end plate. The springs exert a great force when the slide is forward, and diminishes rapidly when the slide is rearward and in a position to repeat the cycle.

Chapter 46

20mm M39 (T160) REVOLVER GUN

ARMOUR RESEARCH FOUNDATION



20mm Revolver Gun M39 (T160)

History

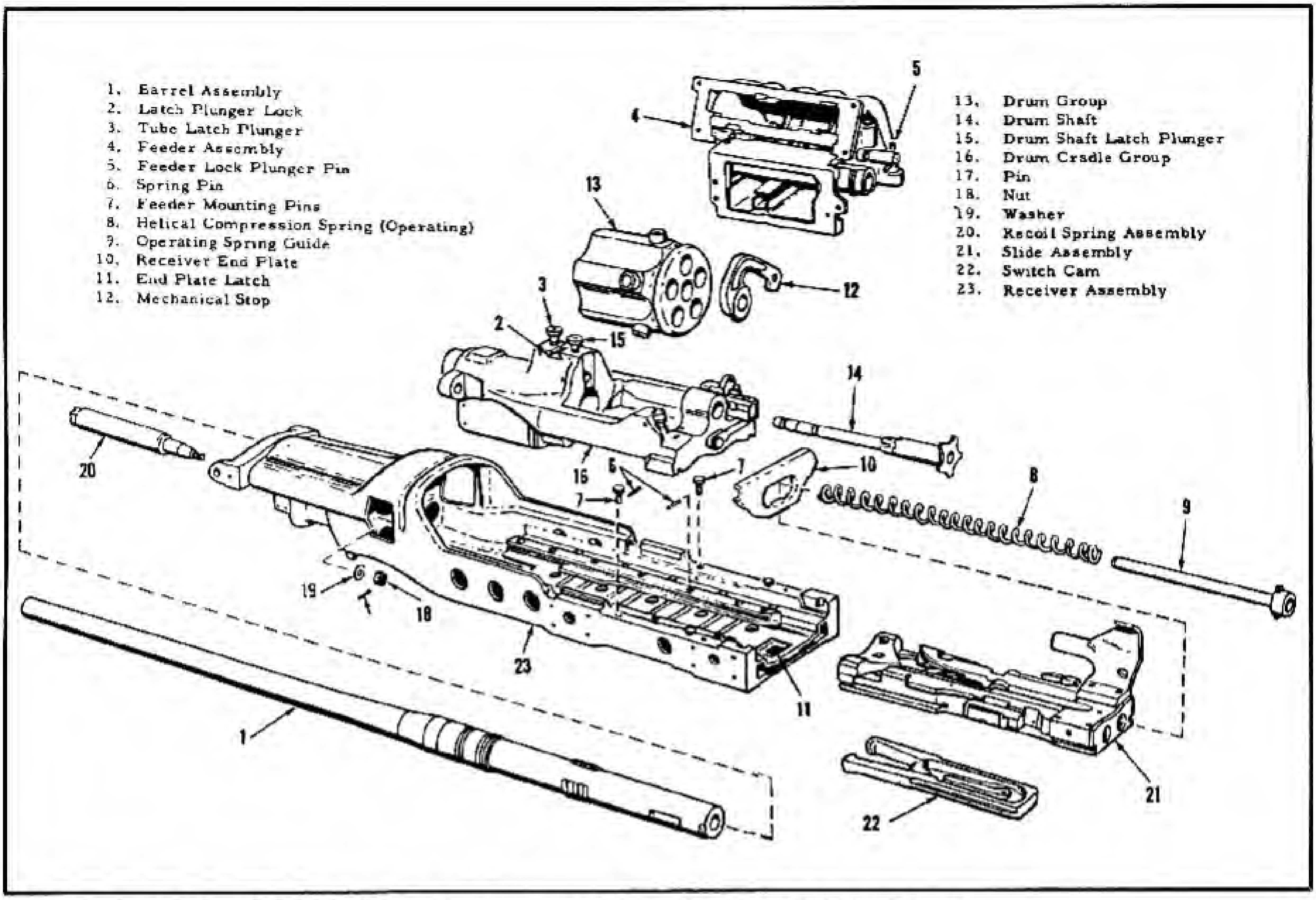
The basic principles of the calibre .60 Revolver Gun T130 (M38) and its 20mm version, the T160 (M39) Revolver Gun, were conceived in the Mauser Works in Germany after the end of hositility of World War II. The Germans fabricated several models, designated as 20mm MG213C and 30mm MG213 and sent them to the United Kingdom. Two guns were shipped to the United States, one of which was assigned to Springfield Armory and the other to Wright Field in Ohio.

In 1946 Springfield Armory studied the German model and prepared a set of drawings from the measurements taken from the weapon components. Late in 1946 the Armory received a set of the German prints and Armour Research Foundation was engaged to undertake developmental work. In 1947 Armour rebuilt the MG213, also studying British developments (The Aden redesign of MG213) and continued to design and fabricate versions in 20mm for the next two years. In the latter part of 1949 Springfield Armory made complete layouts showing a calibre .60 model using the revolver-gun principle. In early 1950 Armour redesigned and fabricated two models in this calibre, and later in the year designed and fabricated a lightweight version, known as the T130 Model C.

Following further refinements by Armour, Springfield turned the drawings over to Ford Motor Company in 1951. This company fabricated the Armour Model D as T130 E1/T160E1. Later that year Ford redesigned the Armour gun into the T130E2/T160E2. With Springfield Armory coordinating the program, Ford redesigned the E1 weapon for limited production into the T130E3/T160E3, including a sheet metal receiver, and fabricated 380 guns in 1951 and 1952.

In late 1951, Springfield Armory turned the drawings over to Rock Island Arsenal for an educational program there. Late the following year, 1952, Ford, continuing improvement, redesigned the E3 gun, which was then designated the calibre .60 T130E4/20mm T160E4. The calibre .60 version along with the comparable Gatling calibre .60 was discontinued when it was found that this ammunition did not have room for adequate high explosive.

In 1952, Pontiac Motor Division, General Motors Corporation, was given a production contract for


1. Barrel Assembly
2. Latch Plunger Lock
3. Tube Latch Plunger
4. Feeder Assembly
5. Feeder Lock Plunger Pin
6. Spring Pin
7. Feeder Mounting Pins
8. Helical Compression Spring (Operating)
9. Operating Spring Guide
10. Receiver End Plate
11. End Plate Latch
12. Mechanical Stop
13. Drum Group
14. Drum Shaft
15. Drum Shaft Latch Plunger
16. Drum Cradle Group
17. Pin
18. Nut
19. Washer
20. Recoil Spring Assembly
21. Slide Assembly
22. Switch Cam
23. Receiver Assembly
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
18
19
20
21
22
23

20mm Automatic Gun (M39A3) - Major Components and Attaching Parts (Left Hand Gun)

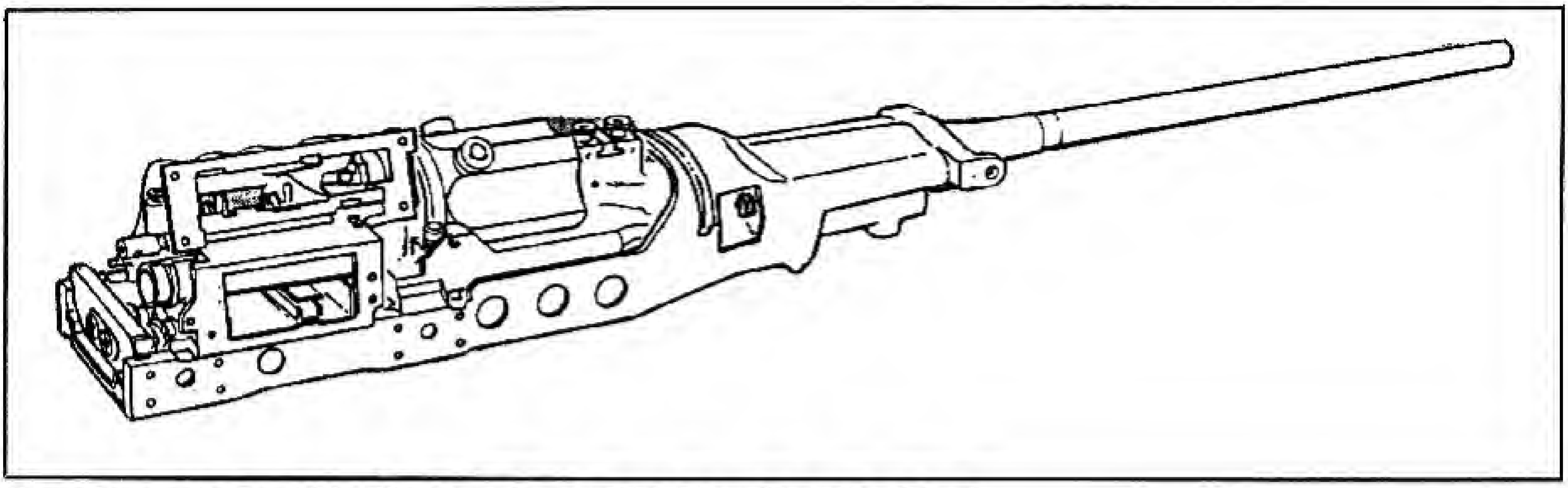
30,000 M39 weapons. In 1955, the second buy for 1640 was given to Cline Electric Co. The industrial responsibility for this particular weapon was given to Rock Island Arsenal. However, during the production orders, there was a continuing product improvement contract at Pontiac under sponsorship of Springfield Armory. Ford and Armour also continued to improve the weapon to include the T160E5 and T160E6 models. Type classification was accomplished in 1953.

In 1954, a contract with Pontiac Motors was negotiated to retrofit all existing guns. In early 1955, the Department of Defense cut back production because of poor reliability of the weapon. Improvements continued up to and including 1959 when solutions to most problems were found.

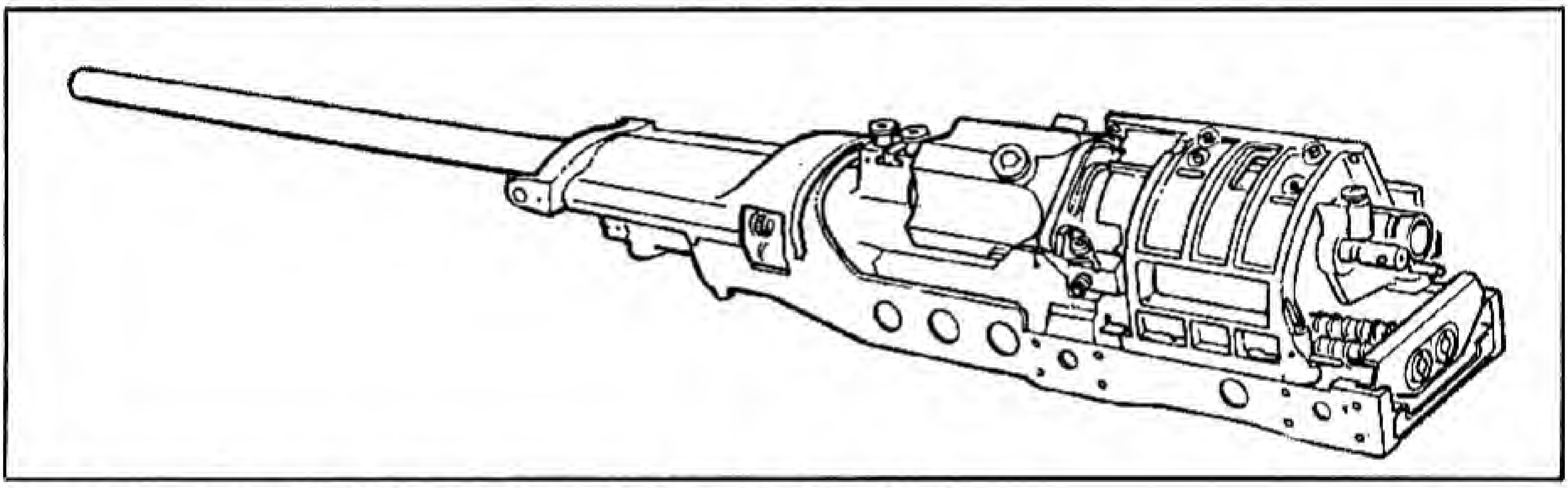
In 1959, the industrial support mission responsibility for the M39 was transferred from Rock Island Arsenal to Springfield Armory. The Armory periodically fabricated repair parts to support the approximately 31,640 weapons that were manufactured and installed in aircraft (F86, F100, F101, B57). Spare parts supplies now constitute the bulk of activity in this program.

The development of the M39 Machine Gun encompassed many facilities which included Norman McDonald & Co. which designed, developed and fabricated the cartridge charger; Dixon Research, Inc. which developed and produced links; Roy S. Sanford Co. which designed and also developed links; Colt Patent Firearms Co. which studied a number of the gun components; Winchester Repeating Arms Co. which evaluated the design; Cornell Aeronautical Laboratory which conducted cook-off investigations and design activities that eliminated cook-off hazard by the use of ring seals; Frankford Arsenal which developed and fabricated ammunition and Rock Island Arsenal which prepared the Ordnance drawings and initiated the production program.

On December 3, 1963, at the request of Colonel C. H. Johnson, Director of Procurement and Production, Hqs, USAWC, Springfield Armory furnished a



20mm Automatic Gun (M39A3) - Three-Quarter Right View (Right Hand Gun)



20mm Automatic Gun (M39A3) - Three-Quarter Left View (Right Hand Gun)

cost estimate on the fabrication of 600 M39A2 weapons at a maximum rate of 75 weapons per month, plus spare parts. The basis for the estimate were: the use of existing tooling, gages and special machines and the current knowledge as to the general condition of same. Initial delivery of weapons would be twelve (12) months after the receipt of product drawings and a production order. As of December 1, 1964, no further action had been taken to activate an order for new M39A2 Machine Guns.

When Springfield Armory ceased its production of the M39A2 Machine Gun its activities were confined to the production of repair parts for the weapon.

Since 1964 continued product improvement resulted, by 1967, in the adoption of the M39A3 version, which differs in some components from the M39A2 gun. The current weapon was produced by the Hydramatic Division of General Motors. Total production of all models of the M39 gun was over 35,000 and while the gun was not mounted on new aircraft, it was still in service (1975) on such aircraft as the F-5.

Description and Purpose

The M39 gun is a single barrel, gas-operated, belt-fed, electrically fired, five chamber revolver type weapon, designed so that ammunition may be fed either from the left or right side. It is utilized by fighter aircraft as an offensive high cyclic rate weapon. The gun is presently employed only in forward firing fixed mounts and is dependent on the flight attitude of the aircraft for target alignment.

There are presently two versions in use, the M39A2 and M39A3. The difference between the two guns are changes in design to include new components or assemblies. Some of these assemblies are interchangeable, however, some parts are not usable for both configurations.

The M39 guns are 73 inches long and weigh 179 pounds with the feeder. The barrel, a quick change type, is 53.5 inches long and weighs 29.5 pounds. The gun uses M50 electric primed ammunition which has a muzzle velocity of 3,300 feet per second giving a maximum range of about 5,500 meters. The minimum rate of fire is 1,500 rounds per minute. The ammunition is belted in M12 push through type disintegrating metallic links.

Cycle of Operation

The mechanical action of the parts and their relationship, one to the other, can be explained more clearly when one cycle of operation is divided into phases, charging the gun and firing the gun.

Charging. Feeding of the rounds is accomplished through a feed chute belt which is secured to the feed mouth of the feeder. A round is aligned with the drum chamber and is removed from the belt by the rammer on its forward travel. The empty links continue around the sprockets and leave the feeder through an opening directly under the ejection chute.

Characteristics

Weight of Complete Gun	179 lb.
Length, Overall	72.2 in.
Width, Silhouette	10.4 in.
Height, Silhouette	8.4 in.
Receiver Length	37.9 in.
Length between Receiver Mounting Points	26.5 in.
Barrel:	
Length	53.5 in.
Weight	29.4 lb.
Quick Change	Yes (interrupted locking lugs)
Method of Operation	Gas
Method of Cooling	Air
Rate of Fire	750 rpm
Horsepower—Weight Ratio	(Horsepower per lb. of gun wt.) 9.8
Cookoff Protection	None
Direction of Feed	Either side of receiver
Belt Pull (min.)	100 lb.
Headspace	Fixed
Method of Charging Gun	Manual
Force Required to Charge Gun (max.)	230 lb. (approx.)
Method of Firing	Electrical Impulse to Firing Pin
Type Primer Ignition	Electric
Case Ejection	Rear or Side of Feeder
Link Ejection	Either Side of Feeder
Link Belt Pitch	1.8 in.
Type Link (M12)	Push through, metallic
Type Flash Suppressor	None
Weight of 100 Linked Rounds	72.0 lb.
Accuracy	The radial dispersion (standard deviation) shall not exceed 1½ mils in a burst of 50 rounds when mounted on a structure having a rigidity of 250,000 pounds per inch deflection.

Ramming is accomplished in two stages, the first of which occurs when the operating slide assembly is moved to the rear and the feeder positions a cartridge into the path of the upper ramming face. The cartridge is removed from its link as the slide assembly returns to battery and is partially chambered into an empty drum chamber which indexes into alignment to receive the cartridge.

The second stage occurs when the drum body indexes and rotates the previously partially chambered round into the path of the lower ramming face. The lower ramming face moves this round forward and depresses the spring loaded round retainer which bears against the base of the chambered round.

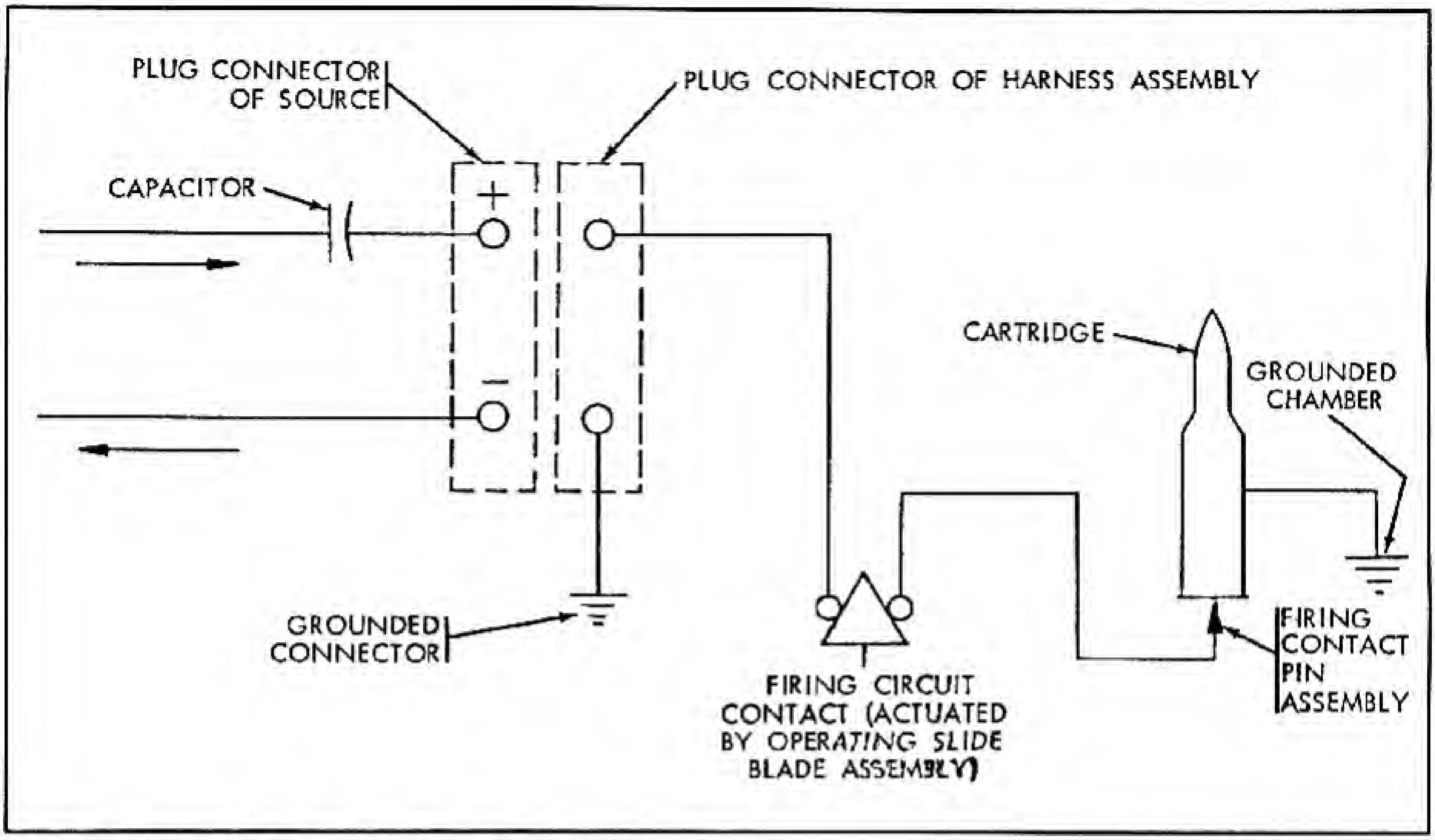
Drum indexing is the revolving of the drum group which indexes the rounds. Action between the drum rollers and the cam path of the operating slide causes the drum body to rotate during cycling.

The switch cam causes the operating slide tongue assembly to pivot during cycling, thereby changing the cam path in the operating slide body.

Firing. This phase of operation is divided into firing, gas operation, recoil, counterrecoil, extraction, and antidouble feed action.

Firing is accomplished after the gun has been charged and contains three rounds: one chambered ready to fire at the 6 o'clock position; one round that is chambered at the 4 o'clock position ready to be indexed into firing position; and one round removed from its link in the feeder at the 2 o'clock position and partially chambered in the drum. The remaining two chambers are empty. Firing only takes place when the operating slide assembly is in battery, and after the firing switch is depressed, thus completing the electric circuit and firing the round.

Gas operation takes place when the propellant gas expands in the chamber and bore as the projectile travels forward. After the projectile passes the gas orifice, the gas which remains in the bore is bled through the gas and receiver orifice into the gas tube. The gas enters the gas cylinder of the drum cradle, which is a recoiling part, through a small opening in the gas cylinder plug. Clearance is provided between the opening in the gas cylinder plug and the gas tube to permit motion between the recoiling gas cylinder


PLUG CONNECTOR OF SOURCE
PLUG CONNECTOR OF HARNESS ASSEMBLY
CAPACITOR
+
−
CARTRIDGE
GROUNDED CHAMBER
GROUNDED CONNECTOR
FIRING CIRCUIT CONTACT (ACTUATED BY OPERATING SLIDE BLADE ASSEMBLY)
FIRING CONTACT PIN ASSEMBLY

Schematic Drawing of the Electrical Firing System

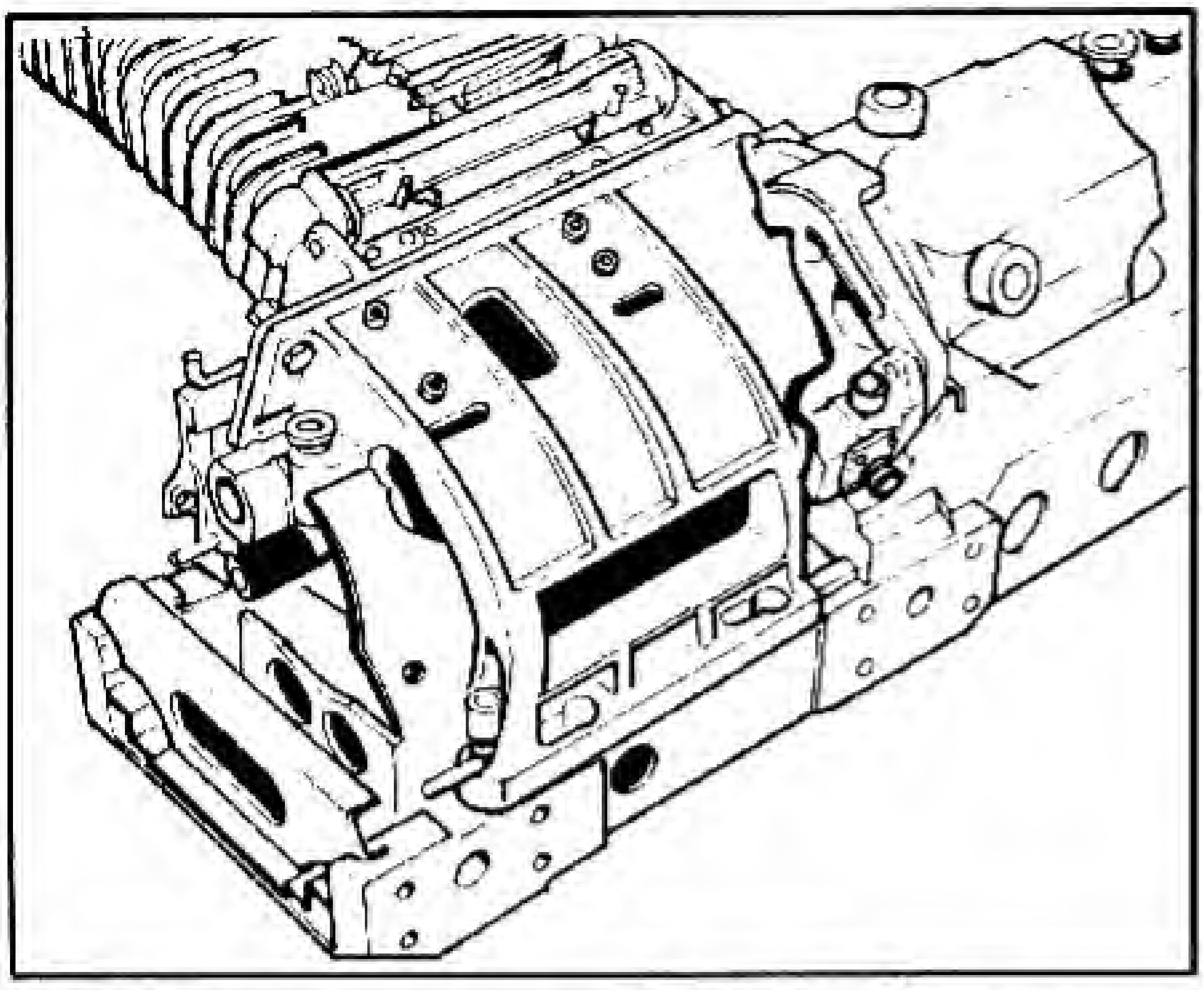
and stationary gas tube. The propellant gases in the gas cylinder force the gas piston rearward, which causes the operating slide to move rearward. A gas port is drilled into the bottom of the drum cradle and extends into the gas cylinder. This port allows entrapped air to be expelled as the piston is forced rearward and acts as an exhaust for the propellant gases after the piston has completed its rearward motion.

Recoil forces are generated when firing occurs and act indirectly upon the operating slide assembly, after the gas operation takes place, forcing it rearward. Two recoil spring assemblies are housed in the forward portion of the receiver. They absorb and limit the recoil to one-quarter inch travel. The recoil springs seat against a shoulder in the receiver and shafts extend through two yokes on the drum cradle body and are locked in place by a nut and washer. Recoil forces acting rearward are transmitted to the recoil spring shafts and cause the recoil springs to compress, absorbing the recoil forces. The opposite end of the recoil springs bears against retainers screwed into the front face of receiver.

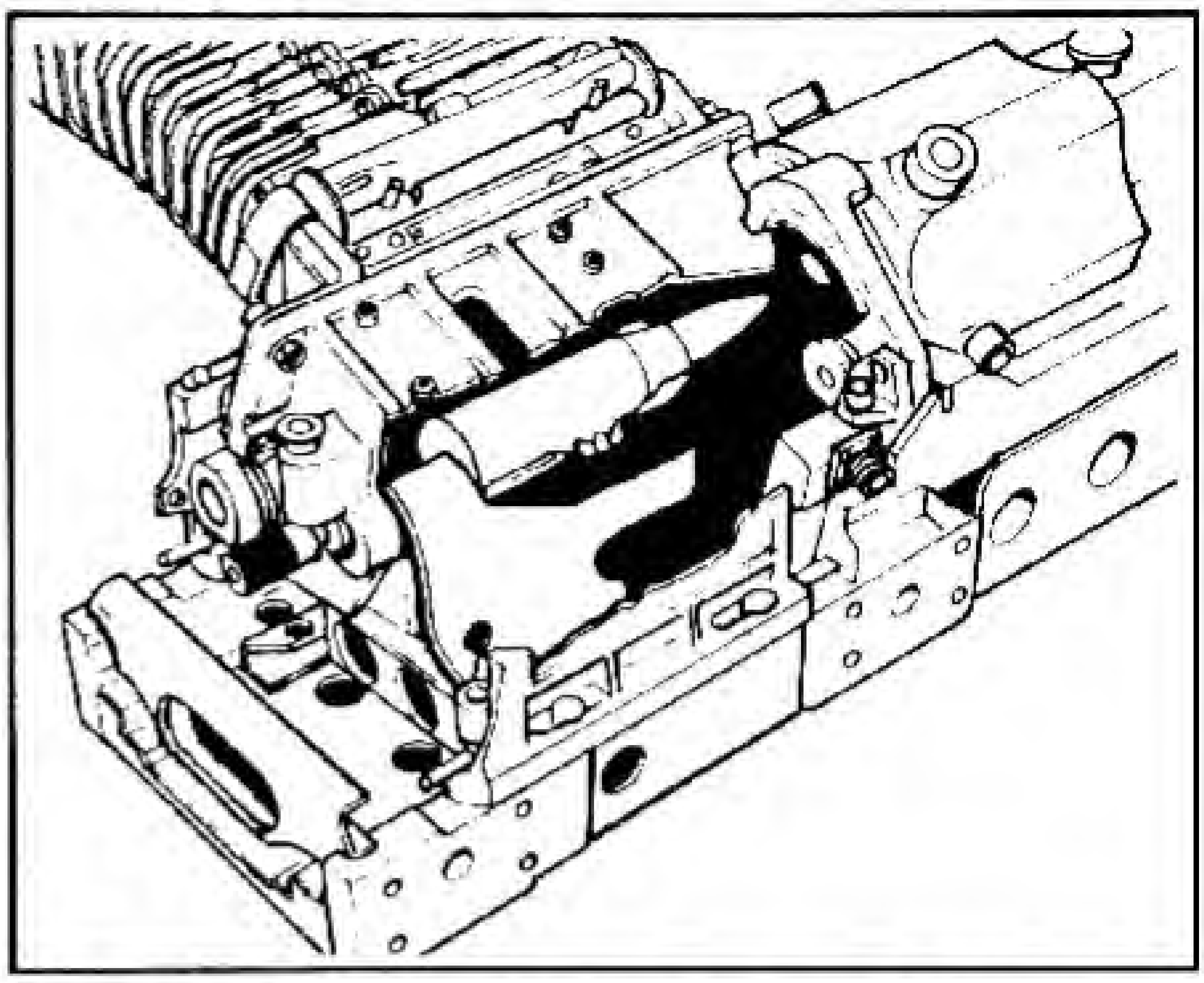
Counterrecoil is initiated when the operating springs return the operating slide assembly to battery. After the gun is in battery, the drum indexing takes place moving the operating slide assembly and drum cradle group forward to the firing position.

Extraction takes place when the cartridge case is indexed in position for extraction. The gases in the gas cylinder cause the drum cradle group to move rearward and the drum roller to move the operating slide assembly to the rear. The camming action within the operating slide assembly controls the action of the extractor.

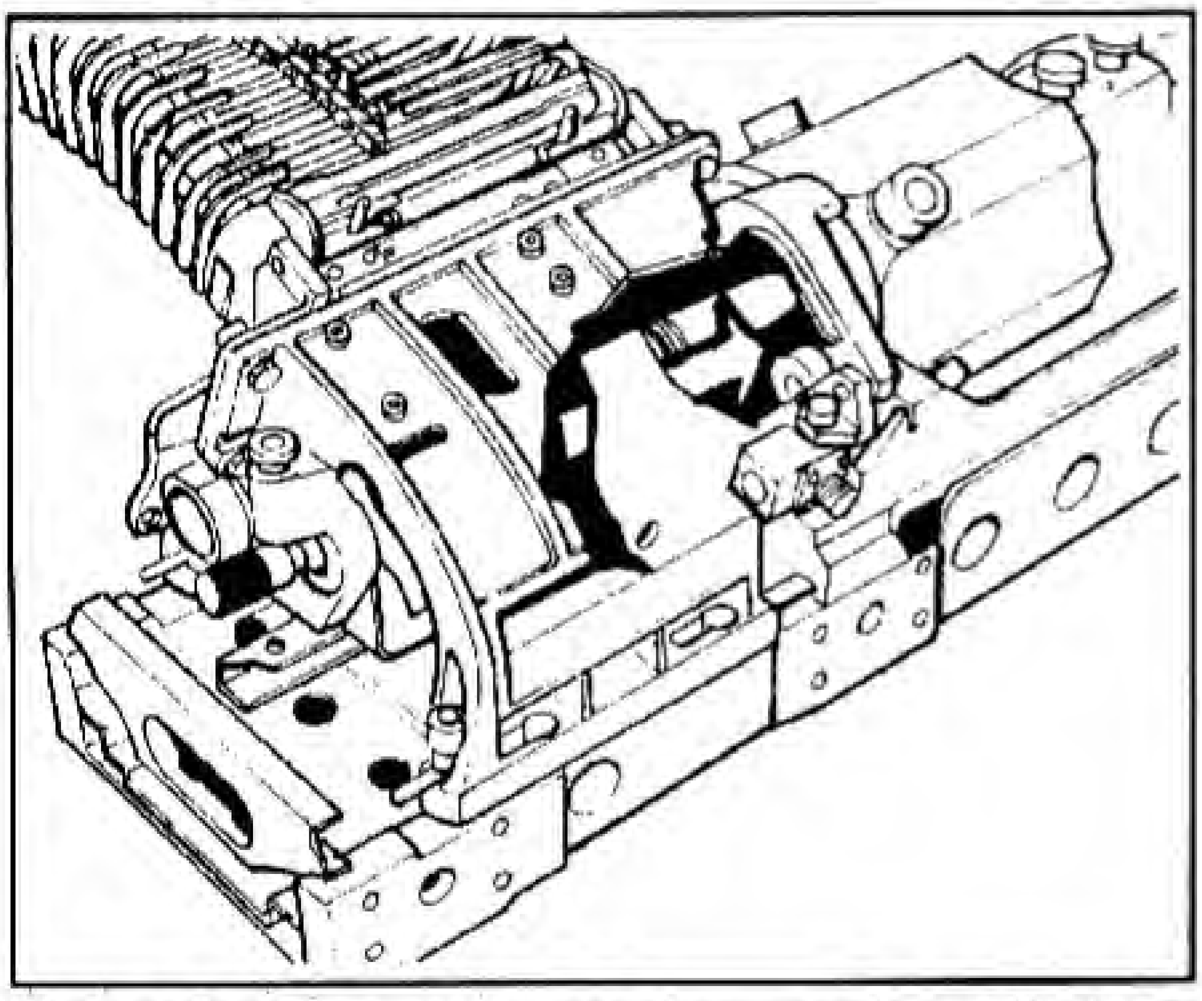
The antidouble feed mechanical stop is a safety device which prevents rotating of a new round in the event a cartridge case is not completely extracted from the drum chamber. The antidouble feed group consists of a bracket and stop (Pork Chop). The stop is secured in position by the drum shaft and stop bracket. A boss on the stop extends over a flange on the drum. Damage to the gun is prevented in the event of extraction failure, by the antidouble feed mechanical stop.



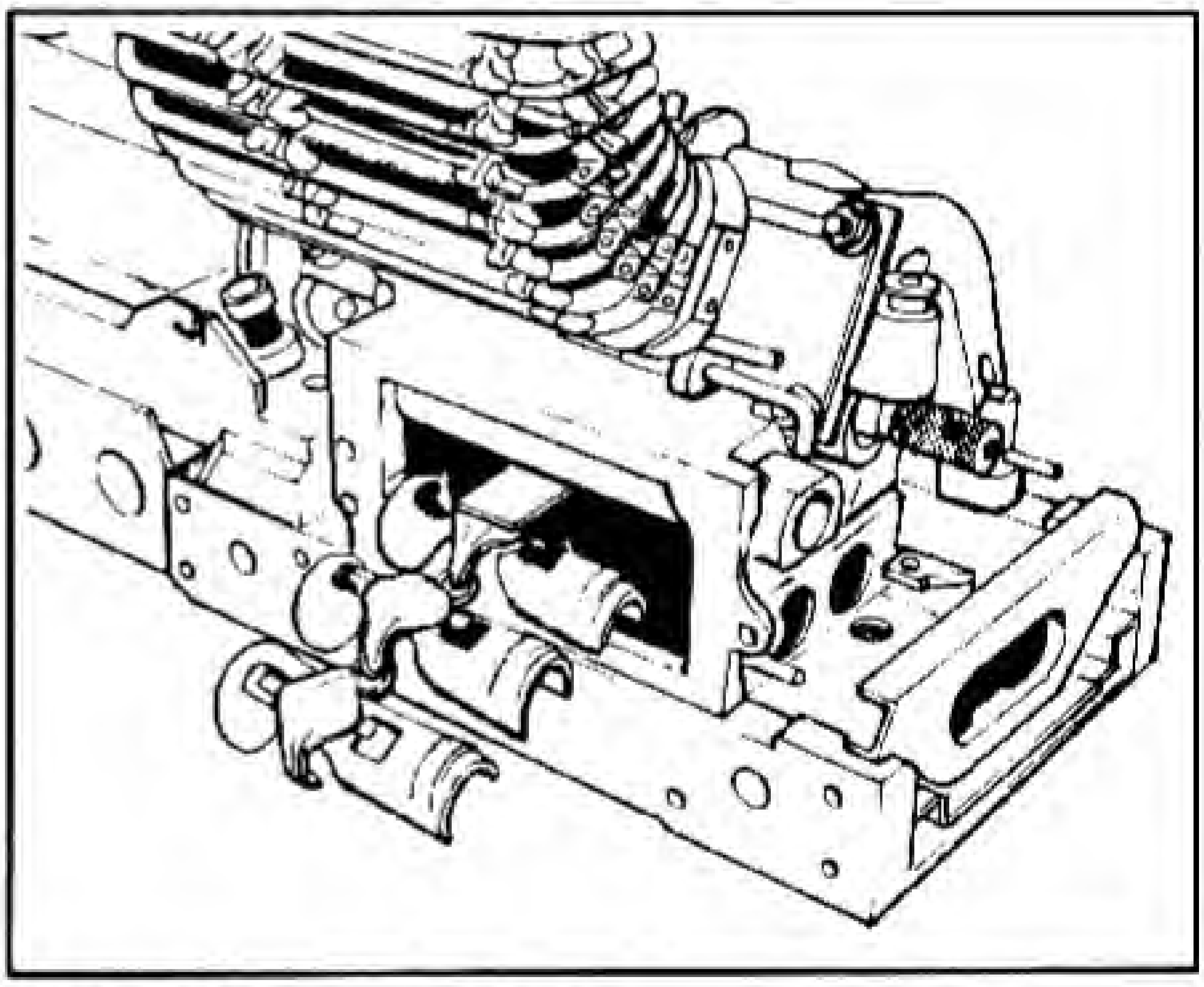
Cycle begins as rammer moves to the rear and the first round is positioned.



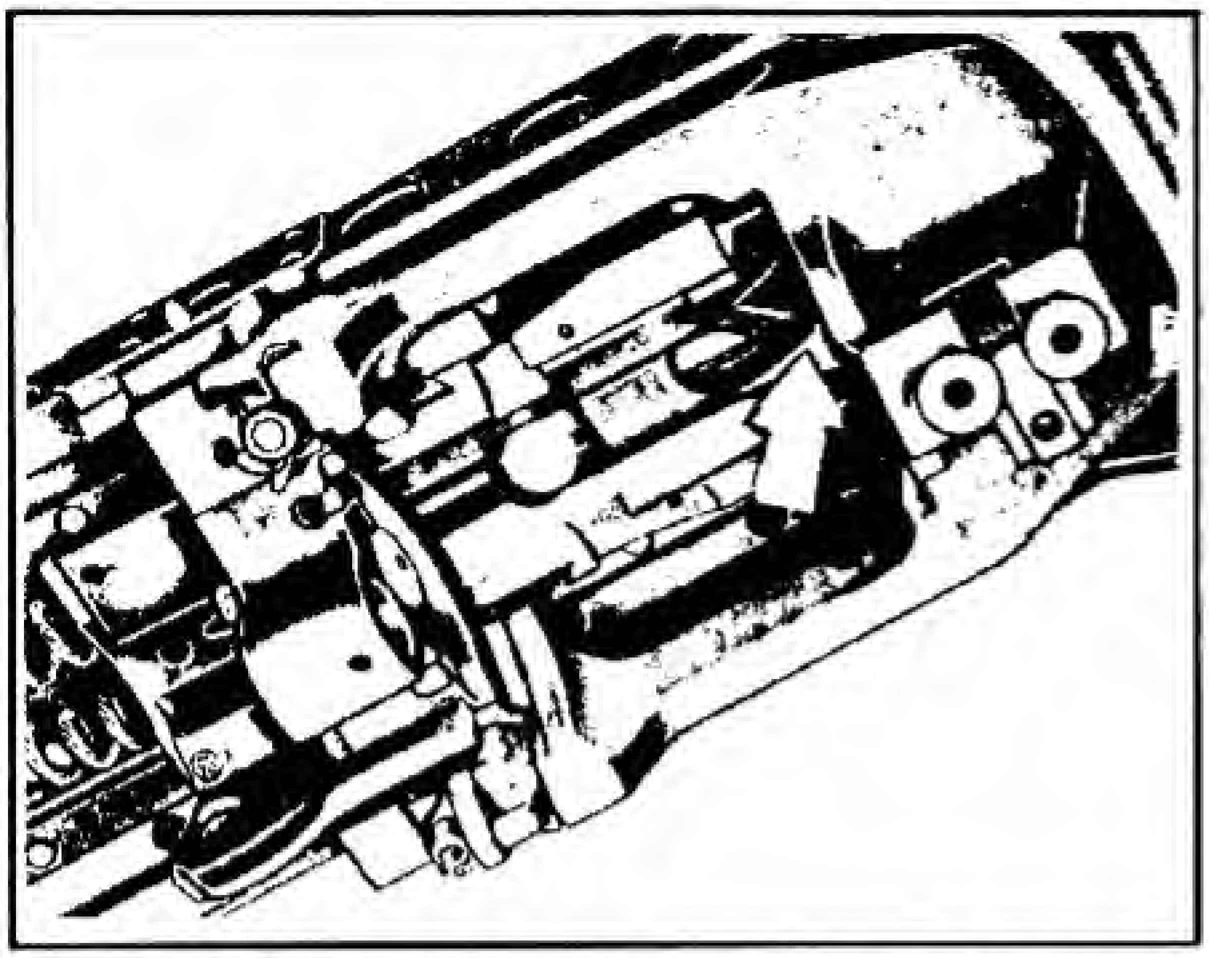
Rammer removes round from link on return to battery.



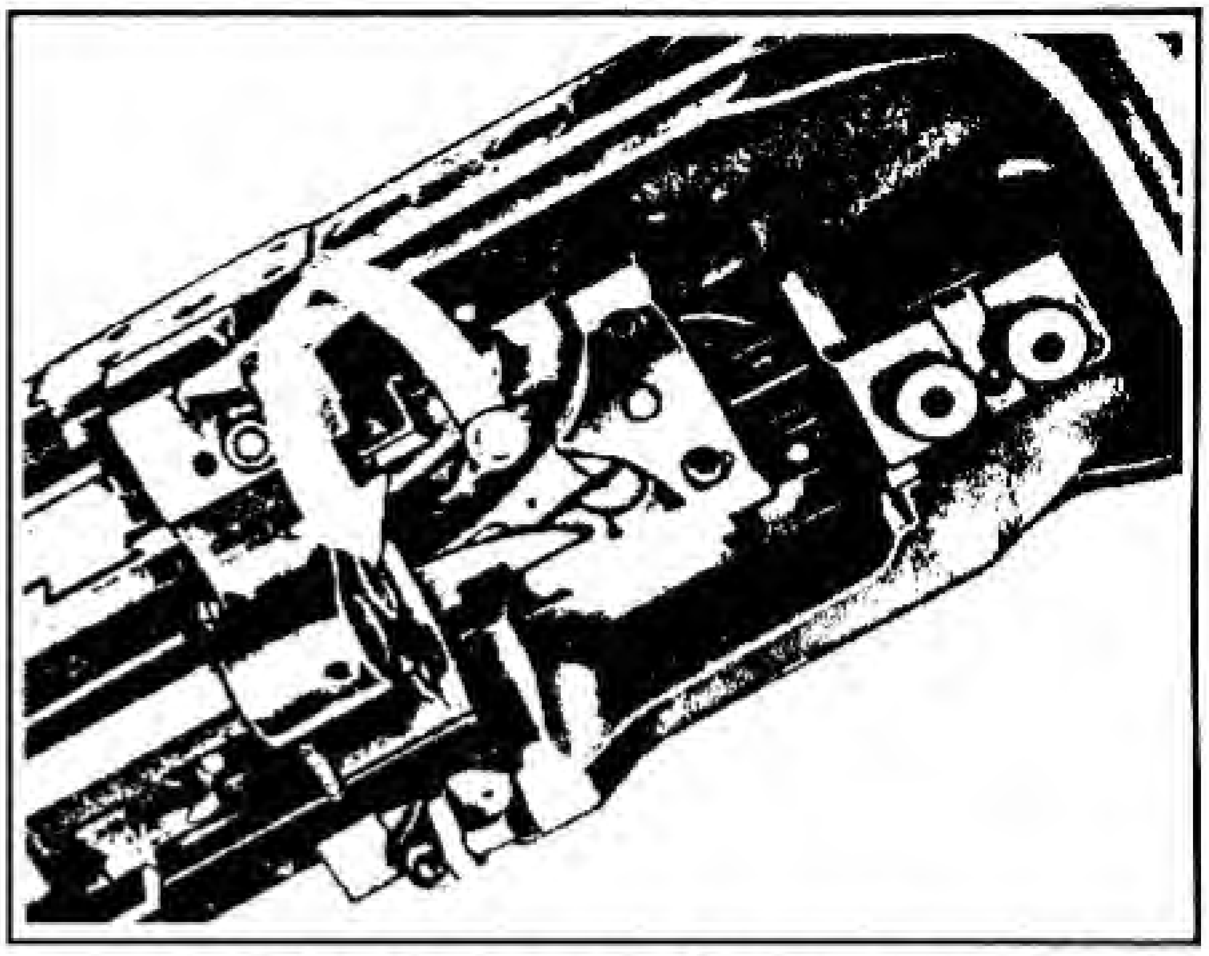
Cycle ends as rammer returns to battery and partially chambering round.



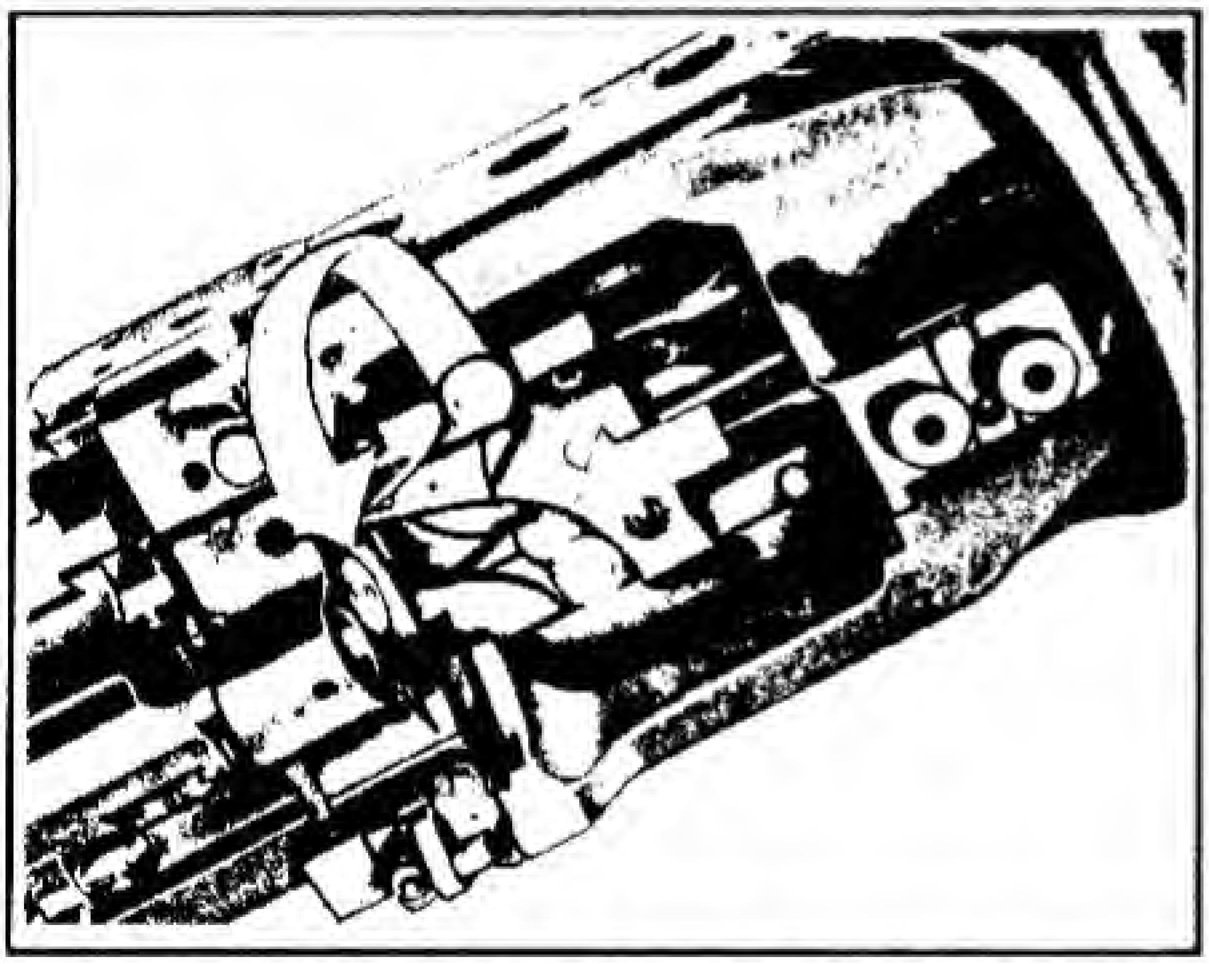
Empty links leaving the feeder.



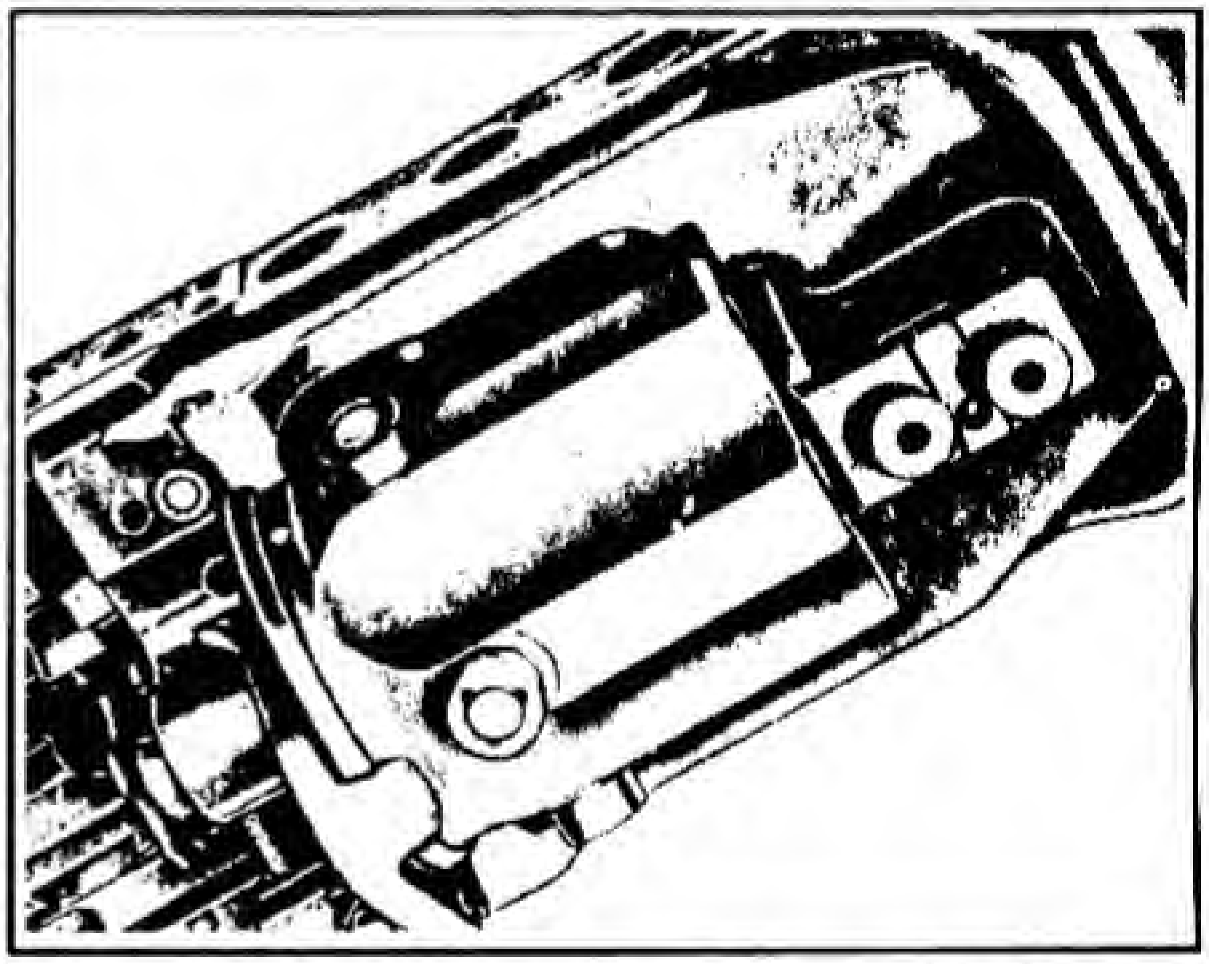
Drum is in battery position when a roller is in the straight portion of the cam path.



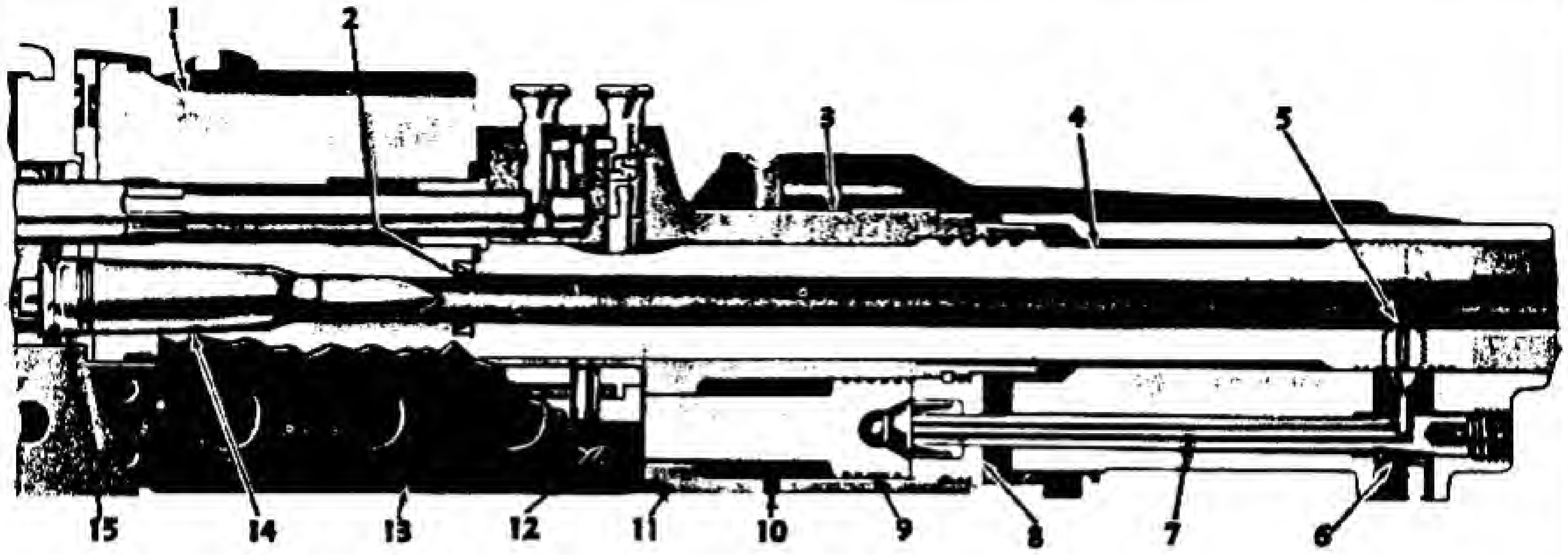
Drum roller follows the cam path of the operating slide as it is returned to the rear and drum begins to index.



Drum roller is about to clear left cam path and adjacent roller is rotated into the right cam path.

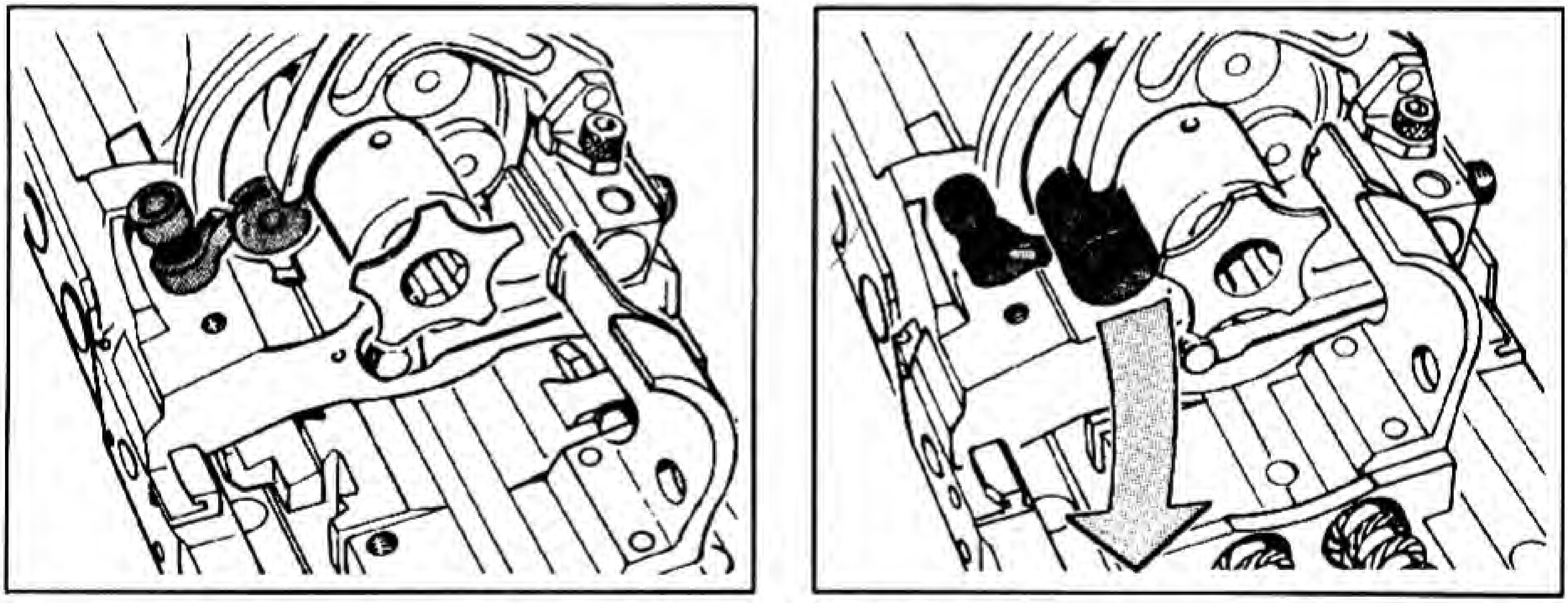


Drum position while operating slide assembly is out of battery.



1. Drum Body
2. Ring Seal
3. Drum Cradle
4. Barrel
5. Gas Orifice
6. Receiver Orifice
7. Gas Tube
8. Gas Cylinder Plug
9. Gas Piston
10. Gas Port
11. Gas Cylinder
12. Operating Slide Assembly
13. Receiver Assembly
14. Cartridge
15. Firing Contact Pin Assembly

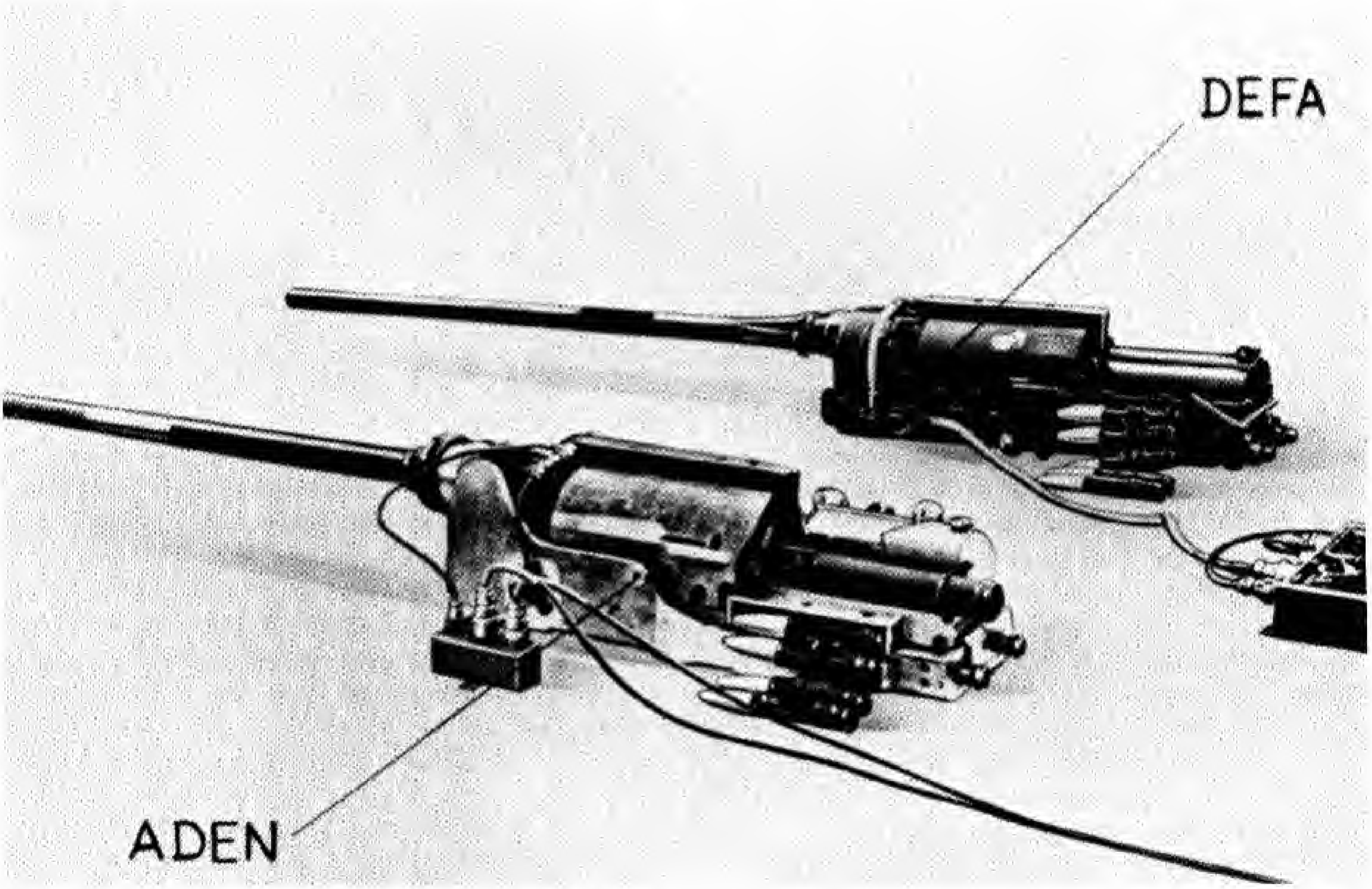
Cutaway Section of Gun



Extraction of Empty Round

30mm ADEN AIRCRAFT CANNON

UNITED KINGDOM



United Kingdom/French 30mm Aden/30mm DEFA Guns

History

An early version of this weapon was extensively covered in Volume III of *The Machine Gun*. The ADEN is now operational with United Kingdom Forces and other countries. It is used by the U.S. Marine Corp, primarily because it was the standard on-board weapon for the AV-8A Harrier aircraft.

Description

The 30mm Aden gun is a large calibre revolver type machine gun with a high rate of fire and is designed for use in a fixed position in aircraft. The gun is fired electrically, and cooling is effected by air flow over the barrel. The weight of the gun is approximately 193 pounds.

Characteristics

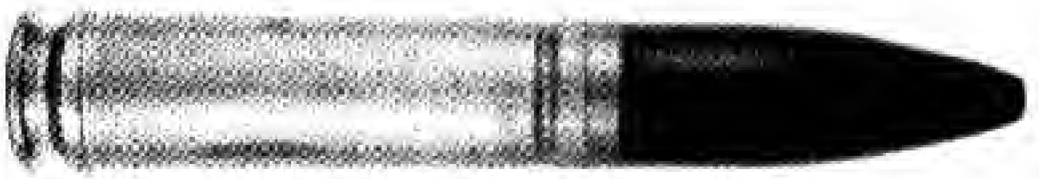
Length	79.1 inches
Width	8.75 inches
Height	9 inches
Weight	193 pounds
Barrel Length	57.4 inches
Barrel Weight	32.2 pounds
Rate of Fire	1200 rpm
Muzzle Velocity	2040 feet per second
Trunnion Load	15,000 pounds
Right Hand Feed	
Electro-pneumatic charger	
Maintenance Requirements:	
Complete Disassembly	800 Rounds
Time to Disassembly, clean, lubricate, and reassemble	1.3 man/hours
Power Requirements:	
Firing Circuit	115 Volts A.C. 24 Volts D.C.
Performance:	
(NWL, Dahlgren; 1512 rounds fired)	756 MRBS

Ammunition is fed to the gun by a belt, which may be of any length depending on the stowage space available. Provision is made for left or right-hand feed, and the change from one feed to the other can be carried out by repositioning certain components.

The gun is gas operated. The slide and feed slide are forced to the rear by gas piston, compressing the return springs between the slide and the rear of the cradle, at the same time rotating the breech cylinder. The combined efforts of the expanding return springs reasserting themselves and the inertia of the breech cylinder camming upon the slide carry the slide and feed pawl forward completing the 72-degree rotation of the breech cylinder and firing a round. During the counterrecoil of the feed slide, a round is stripped from its link, a second round is chambered, and the empty case of the round originating the cycle is ejected.

When a round is fired, the barrel, breech cylinder housing, and breech cylinder recoil a maximum of three-fourths of an inch. The feed mechanism is coupled to the breech cylinder and rotates with it. At the moment of ejection, the feed mechanism sprockets are clear of the ejection opening. The rounds are driven through the links by the rammer face of the feed slide, the links being ejected through the feed mechanism link ejection opening.

The gun may be divided into two groups, the nonrecoiling portions and the recoiling portions. The nonrecoiling portions are: barrel, breech cylinder, breech cylinder housing, gas cylinder, buffer spindle, slides, and feed slide.



30mm Aden Aircraft Cannon Ammunition. (Photo courtesy of Woodin Laboratories.)

Test Results

A NWL, Dahlgren report concluded:

> "The limited technical evaluation of an existing 30mm aircraft weapon and the Aden cannon has not revealed significant performance differences in the two weapon systems. Based on the information gained from these limited investigations, no strong argument can be made in favor of replacing the Aden cannon with any other revolver type weapon."

Chapter 48

30mm T168 SERIES MACHINE GUN
UNITED SHOE MACHINERY CORPORATION

History

The research and basic concept work performed by United Shoe Machinery Corporation for the development of the 30mm Automatic Gun T168 was later supervised by Springfield Armory. Work under this contract was started September 1951 and terminated June 1957. During this period a feasibility study was conducted and three different guns were designed, built, and tested. The three models were designated: Firing Model, Gun #1, Gun, Automatic, 30mm, T168; Prototype Model, Gun #2, Gun, Automatic, 30mm, T168E1; and Receiverless Model, Gun #3, Gun, Automatic, 30mm, T168E2.

The object was to design, build, and test a short 30mm automatic weapon whose characteristics would make it suitable for installation in tail turrets of bomber aircraft.

Springfield Armory initially visualized a revolver type gun which would ram a reverse-tapered cartridge into the front of the revolver drum. This would show a gun of minimum length for a given barrel length, the feeder would be located near the center of the weapon to minimize twisting and turning of the flexible chuting needed to feed the gun, and the empty cases could be ejected in the same direction as the travel of the bullet which would help to get the cases out of a tail turret.

Equally important was the development of a lightweight reverse-tapered T268 cartridge and the totally enclosed T83 link. The design of the gun, link, and cartridge were integrated in an attempt to produce an optimum weapon for turret installation. On the third gun, the T168E2, the weapon and turret design were integrated.

The program was divided into phases. Phase A covered the feasibility study in which United Shoe Machinery conducted a design and engineering study of the T168 gun, ammunition, and link, leading to the selection and rough layout of a practical mechanism and link.

Phase B covered the design activity for the first model gun, T168, and started about one month after the conclusion of Phase A. Minor shop work was performed to evaluate features, engineering and study were completed, and a final layout and detail drawings were prepared.

In June 1952, United Shoe Machinery was authorized to conduct a test of the proposed rammer gearing for the first model T168 gun. These tests were made with a 30mm T121 gun borrowed from Springfield Armory and fired at United's Tweksbury range. This test, part of Phase B, was not completed until after the Phase B Final Report was written. The results were inconclusive because the T121 gun fired British Aden ammunition and did not supply enough energy to cycle the rammer gearing at the desired rate of 1500 rpm.

Phase C covered the manufacture and test firing of the T168 and T168E1 guns. Originally, this phase was to be completed by January 31, 1954 and was to cover the manufacture and testing of one model gun, including one feeder and an adequate supply of links, plus the manufacture of an improved prototype model gun.

The T168 gun was completed first; manufactured drawings for the first gun parts were sent to the shop in August 1952. Manufacturing of the links was delayed about two weeks until link design was approved. While the gun parts were being manufactured, investigations of various methods for reducing the weight of future models were made. By this time, the receiverless design, later to be designated T168E2, was conceived.

The first model gun (T168) was assembled in June 1953, and test firing was started. In November 1953, a second gun was built to expedite testing. Rather than duplicate the first gun, however, the changes found necessary in testing the first gun were incorporated into the second gun design. Work on this design required a temporary interruption of work in the receiverless design (T168E2).

The second gun was later designated the T168E1 and had an aluminum receiver similar to the first model but it had a lightweight barrel and an improved gas piston and rammer gearing design. The lightweight barrel weighed 18 pounds compared to 31 pounds for the old design. Because of the lighter barrel, the gas piston could be more centrally located to reduce off-center loading. The rammer gearing was also modified. The T168E1 was built and test firing started in September 1954.

Both the T168 and T168E1 were test fired to establish design data for the design of the T168E2 gun, and to prove the reliability of the T168 principle of operation. In September 1955, a cap on the breech end of the T168 gun barrel burst and damaged the drum support beyond repair. A total of 2557 rounds had been fired.

The T168E1 gun was fired until April 1956 for a total of 1,861 rounds. From April to July 1956, the remaining effort was directed toward firing the T168E2. The T168E1 gun was shipped to Springfield Armory in August 1956.

Phase D covered the activity associated with the T168E2 (receiverless) model gun. The intent was to build six guns and 10,000 links but this was later reduced to one gun and 1000 links. The early investigation work was done during Phase C. Consequently, there was some overlap of phases and activity.

Following the assembly of the T168E1 gun in September 1954, investigation and engineering work on the T168E2 design resumed. The desired weight limit for the T168E2 was set at 150 pounds with a desired firing rate of 1500 rpm. In the T168E2, as proposed, the components normally supported by the receiver were to be positioned by extension of a redesigned drum support. The turret elevation wheel was to be cast to include the recoil housings and the front and rear drum support guides for each gun to insure accurate location of the two guns relative to each other when installed in a turret. The feeder was to be attached directly to the drum support and recoil with it. No other changes in operating principles were contemplated.

In December of 1954, a series of engineering tests were conducted on the T168 gun to establish specific design data for the T168E2 gun. These tests resulted in recommendations which were expected to produce a weapon with the desired characteristics.

Design activity was started and progressed far enough to hold an engineering meeting May 10 and 11, 1955, when the design was approved. One T168E2 gun was built and test firing was started in February 1956. These tests resulted in several changes to improve reliability. Test firing was completed in July 1956, after firing a total of 447 rounds.

Brief operation and assembly instructions dated October 1956, were prepared for the T168E2 gun, and both the T168E2 and the T168E1, along with accessory parts and material, were shipped to Springfield Armory.

Description and Purpose

The objective of the T168 program was to design, build, and test a short 30mm automatic gun whose characteristics would make it especially suitable for installation in tail turrets of bomber aircraft. The

Characteristics

Bore Size	30mm
Muzzle Velocity	2800 fps
Rate of Fire	1300 rpm
Basic System of Operation	Gas
Locking System	Other
Power Source Feed System	Gas
Feed System	Sprocket Type
Type of Feed (Location)	Link
Method of Chambering	Ram
Type of Receiver	Machined
Weapon by Source	U.S. Army
Developer	United Shoe Machinery
Utilization	Tail Turret
Gun Size:	
Length	54 in.
Width	15 in.
Height	9.5 in.
Weight	270 lb.
Barrel:	
Weight	31.5 lb.
Type of Ejector (Location)	Knock-out (drum support)
Type of Firing Mechanism	Electric
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Pyrotechnic
Ammunition Type	T268 Unconventional

T168 was a four chamber revolver type gun which would ram a reverse tapered cartridge into the front of the revolver drum. This arrangement provides for a gun of minimum length for a given effective barrel length, the feeder could be located near the center of the weapon to minimize twisting and turning of the flexible chuting needed to feed the gun, and the empty cases could be ejected in the same direction as the travel of the fired projectiles, which would help to get the cases out of a tail turret.

The final design, T168E2, was a receiverless version and was 54 inches long, 15 inches wide, 9.5 inches high and weighed 162 pounds. Gas ejection was used for last rounds fired with this weapon. Rates of fire varied from 861 to 1,200 rounds per minute. The muzzle velocity of the T268 cartridge was 2,800 feet per second.

Cycle of Operation

In operation, firing an electrically primed cartridge initiates the cycle. An orifice in the barrel bleeds gas to a cylinder whose piston drives the actuating slide rearwardly. The piston is stopped after a stroke of approximately one and seven-eighths inches but the slide continues under its own momentum.

During the first two inches of the actuating slide motion, the rammer is retracted sufficiently to clear the links in the feeder. The slide continues rearwardly through the curved portion of the cam and rotates the drum 45 degrees. At the same time, the slide also compresses the driving springs. At the end of its rearward travel, the next drum roller enters the cam track and the kinematic energy in the drum, plus the energy from the compressed drive springs, drives the slide forward to its battery position. The slide moves forward two and one-half inches during the last 45 degrees of drum rotation. When the drum stops rotating, the rammer makes contact with the ogive of the cartridge. The remaining three inches of slide motion causes the rammer to chamber the next round and eject the fired case. When the slide returns to battery it closes an electrical switch, the next round fires, and the cycle repeats.

Link Development

Simultaneously with the development of the gun and ammunition, a compatible link was designed and built for use with the T168 gun.

An open type, one-piece link was proposed at the conclusion of Phase A. The design was similar to the T63 link which also used the hook and eye type connector. An open type link was necessary at that time because the specifications called for a relinking type feeder as well as a conventional disintegrating type. A relinking feeder positioned empty links in front of the ejection chamber, ejected empty cases into the link, then pushed both out of the gun.

During Phase B, the requirement for a relinking feeder was dropped. United then designed a one-piece closed type link. Plastic models were made with wooden molds to illustrate link shape. This closed link was designated T83.

The first lot of 50 links was made from hand-shaped blanks with the aid of two simple forming tools. These links were fire-tested and proved satisfactory enough to warrant building single station punch press tools for manufacture of additional lots.

The design end stripping force was set at 25 pounds. However, the first lot of links had a measured end-stripping force of 35 pounds. Fire tests showed that this end-stripping force was not high enough. Successive lots were altered by adding to the length of the detent that fits in the crimping groove of the cartridge. This additional length increased the end-stripping force first to 65 pounds then to 95 pounds. Finally, it was increased to 120 pounds by using thicker material.

The pitch distance was lengthened 1/32-inch to insure stacking in parallel layers. No change in sprocket design was needed to accommodate this pitch change. When the material thickness was increased, the sprocket teeth had to be reduced accordingly.

Forty feet of flexible chuting was made by Standard Armament Inc. for the T268 cartridge and T83 link. This chuting utilized the abutments on the links for maintaining longitudinal control of the cartridge. Also, several short pieces of flexible chuting for empty links were built to guide the empty links away from the gun. The purpose of the link chuting was to conduct tests to insure that United's T83 link design would meet the requirements imposed by a turret installation.

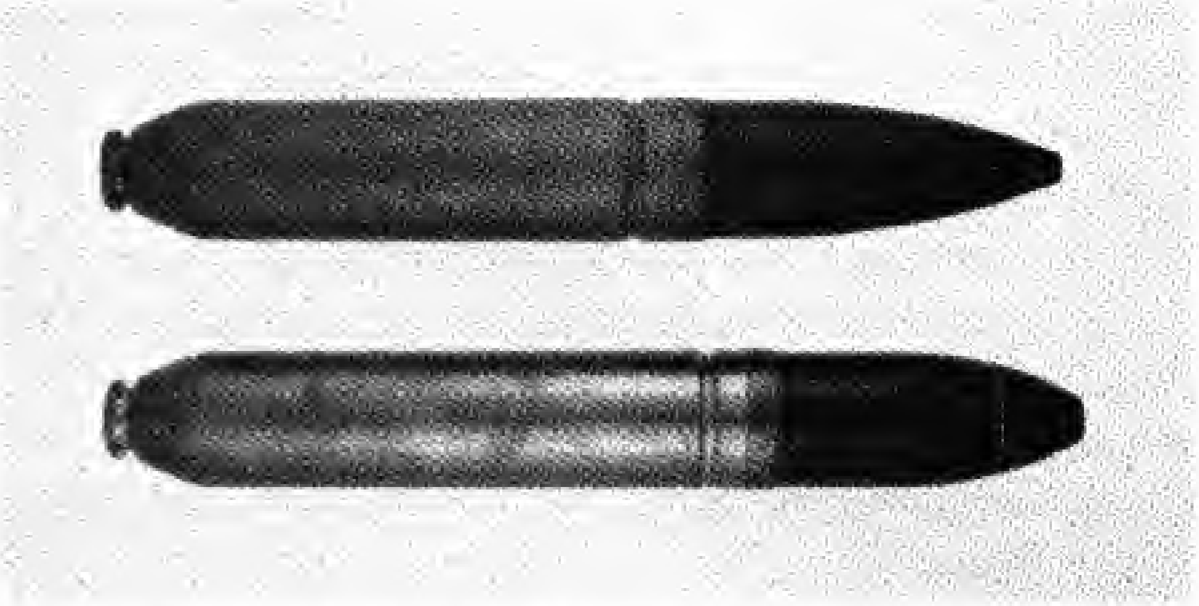
Ammunition Development

Simultaneously with the development of the gun and links, Frankford Arsenal undertook the preliminary testing and manufacture of the reverse-tapered cartridge to be used in the T168 gun. In November 1952, modified Aden cases were successfully fired at the Pitman Dunn Laboratory at Frankford Arsenal.

Frankford Arsenal then manufactured several lots of cartridges using a 3200 grain T304 projectile in place of the 4200 grain Aden projectile. The muzzle velocity was increased from 2000 fps to 3000 fps. This new round was designated Cartridge, Practice, 30mm, T224.

In May 1953, the Winchester Arms Division of Olin Industries Inc. took over manufacture of the reverse-tapered T224 cartridge to support the test fire program. Olin made several lots of T224 cartridges until June of 1954 when the projectile was again changed. The new T328 projectile was one-half inch shorter and weighed 3900 grains. The muzzle velocity was kept at 3000 fps. The new reverse-tapered practice cartridge with the T238 projectile was designated Cartridge, Ball, 30mm, T268.

Following the successful manufacture of brass cases for the T268 cartridge, Olin (later to become Olin Mathieson Chemical Corp.) produced two lots of T268 cartridges with aluminum cases. This was in addition to their production of brass-cased cartridges. Adverse test results with aluminum and a desire to concentrate on gun functioning were the determining factors in deciding to halt the development of aluminum cases. The remainder of the test firing was conducted with brass-cased T268 ammunition. Olin Mathieson Chemical Corp. produced and shipped a total of 10,094 rounds of reverse-tapered ammunition, of which 94 had aluminum cases.



30mm Ammunition (2 Lengths) for T168 Series Guns. (Photo courtesy of Woodin Laboratories.)

Chapter 49

37mm T172 REVOLVER GUN
ARMOUR RESEARCH FOUNDATION

History

Although in 1951 a T37-type bolt action automatic gun had been selected on the basis of Ballistic Research Laboratory studies as probably the best type to be developed for an interim light anti-aircraft weapon, it was decided from the outset of the project to consider a 37mm revolver gun as a competitive development. This gun was designated the T172.

The principle of a revolver-type high-velocity, high-cyclic-rate gun, as employed in the German Mk 413 had been successfully applied in the T130 calibre .60 aircraft gun and in 1951 it was also adopted for the first design of the T157 calibre .60 anti-aircraft gun. A kinematic study which showed that the same principle could be utilized in designing the T172 37mm gun was completed in January 1950.

After the completion of this study, it was decided to design, fabricate, and test-fire a T172 (Model I) gun. The experience thus gained was needed to update the two T172E1 (Model II) guns, one to feed from the left, the other from the right. The finished product was to be constructed so that they could be twin-mounted with a minimum of replacement parts on any selected turret. It was planned to test the T172E1 and compare the results with the T172E2, which was the anti-aircraft version of the 37mm reciprocating gun.

Description and Purpose

The T172E1 is a gas-operated, belt-fed, electrically-fired, revolver-type gun. Its distinguishing feature is a revolving drum upon a shaft within the drum support. A chamber in the drum is held in alignment with the tube during firing, the drum is then indexed to bring the adjacent chamber into alignment with the tube by means of rollers on the periphery of the drum which engage a cam track on an operating slide in the bottom of the receiver.

The barrel of this version is 70 calibres in length. Unlike the previous model, it has a progressive, rather than a uniform rifling twist. This barrel is assembled through the front bearing and is rotated 90° to engage interrupted threads in the drum support and the front bearing. The drum support not only provides bearings for the shaft on which the revolving drum is mounted, but also houses the extractor and the firing pin.

The T172E1's receiver is a weldment of double-walled construction and is 69.875 inches long, only half the length of the original T172 receiver. The receiver contains the trunnions, guides for recoiling parts, and means for mounting the recoil system and the feeder.

Internal soft-spring mounting is incorporated in the T172E1. With this type of recoil system, first applied to aircraft guns, the recoiling parts of the gun remain out of battery during burst firing. During the cycle of operation the recoiling mass oscillates about a point that is at an average distance out of battery, while the corresponding reaction forces are similarly controlled to prevent the return of the gun to battery. This kind of mounting causes minimum disturbance of the gun's supporting structure and sensitive equipment, such as electronic fire control instruments. Two preloaded air springs are employed in the T172E1 design; they permit the recoiling parts to oscillate between 2.5 and 3 inches at an average distance of 3 inches out of battery position.

The adoption of soft-spring mounting necessitated a new approach to the feeding problem and a special design study was conducted to determine the best means of transferring ammunition from a stationary feeder to an oscillating firing station. The solution was found by arranging the several feeding functions around a floating transfer sprocket extending from the drum support, with which it moves in recoil and counterrecoil to the rear of the feeder which is bolted to the receiver. As the ammunition belt is pulled into the feeder, the rounds are stripped out of the links by the cam action and pushed into position in the transfer sprocket, which guides their movement as they are chambered by a two-stage rammer. The feeding mechanism is energized by rotation of the drum.

This gun was intended for a light anti-aircraft twin turret mount.

Characteristics

Length, Overall	138 inches
Length of Bore	70 calibre
Weight, Complete	1,100 pounds
Firing Mechanism	Electric
Muzzle Velocity	3,000 fps
Rate of Fire	1,100 rpm

Cycle of Operation

When a round is fired, powder gases are bled from the tube into a cylinder in the front bearing of the gun. A piston in this cylinder, which is attached to the operating slide, is driven rearward, carrying the slide with it. The drum is indexed one-half station on the rearward stroke of the slide and one-half station on the forward stroke; this is effected by interaction between the rotating drum and the cam in the slide, assisted by a nitrogen recuperator. In addition to indexing the drum, the slide also actuates the extractor (by cam action as the slide is completing its return to battery) and mounts the rammer; the latter chambers the round before the drum is indexed the second one-half station.

Test Results

Firing tests of the T172 which began in January 1954 indicated a cyclic rate of approximately 700 rounds per minute. Even though this was higher than the specified rate of fire for the weapon, the T172E1 guns were designed to have a shorter slide stroke during the ramming operations, a modification calculated to increase the cyclic rate to 1,000 rounds per minute. By the end of 1954 both T172E1 guns had been completed. Preliminary firing tests indicated a cyclic rate of approximately 1,100 rounds per minute and 100 rounds were fired initially without major malfunction or noticeable barrel erosion.

Because the maximum belt pull is about 2,000 pounds (as compared with a pull of 420 pounds in the T37E2 gun), the T26 link designed for use with that gun cannot be used with the T172E1. A reinforced metallic belt link, designated the T92 was designed and was tested for reliability in long-burst firing.

The T172E1 gun was to fire the same ammunition as the T37E2, namely, the T181 or T324 37mm high explosive shell.

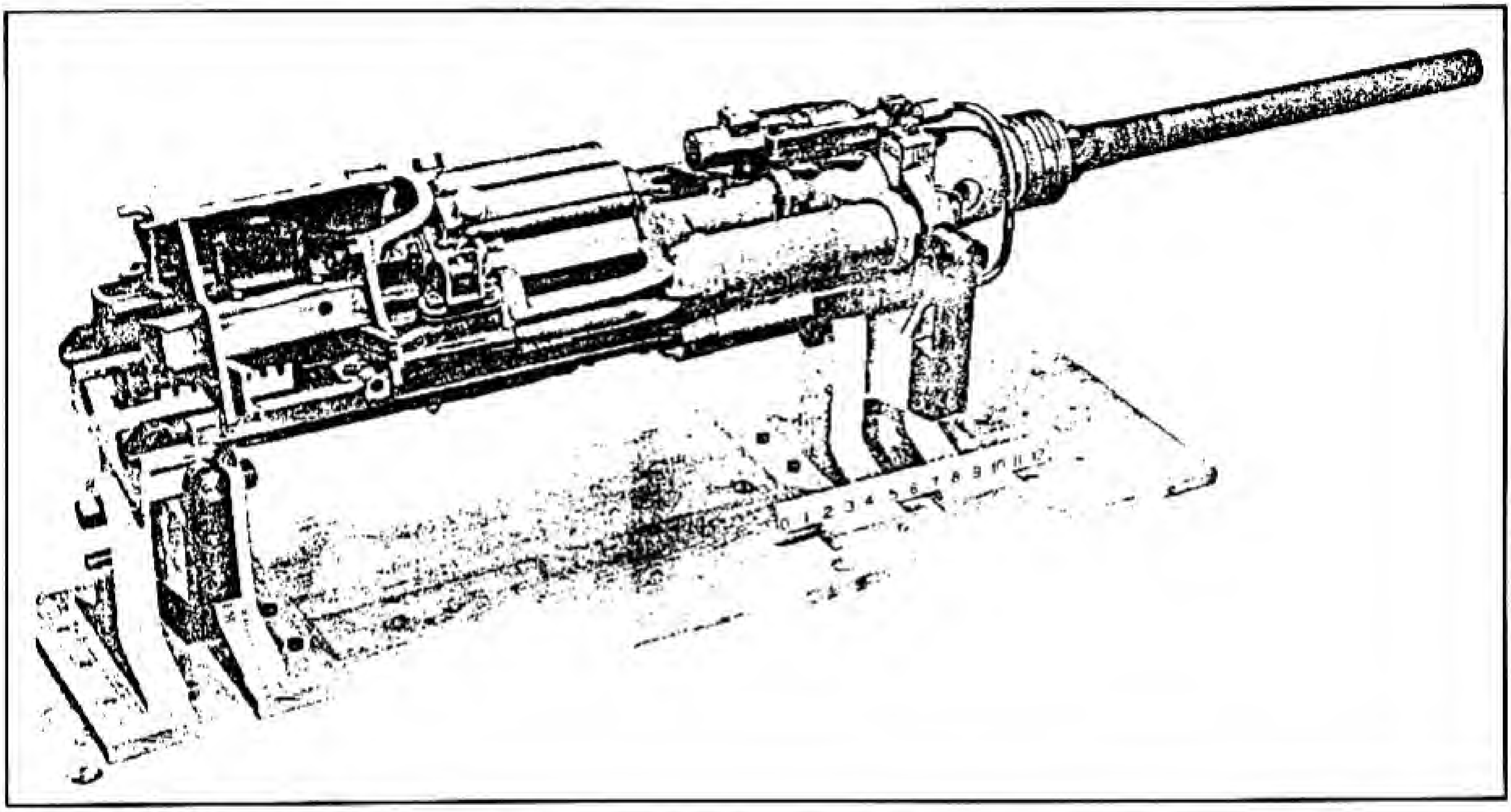
ARF was delegated to assemble a test model of this gun on a standard M2A3 40mm AA gun carriage.

Armour Research Foundation developed the weapon. Work ceased in late 1956.

Chapter 50

30mm AUTOMATIC GUN T182 SERIES

FORD, BUFFALO ARMS, OLDSMOBILE



30mm T182E3 Automatic Gun

History

The design, development, and fabrication of the T182 30mm revolver gun began early in 1951. The initial development used low velocity ammunition and was carried out by Oldsmobile Division, GMC. Fabrication of the 30mm weapon began in February 1951 and continued through August 1954. In August 1954, Oldsmobile requested that their development contract not be continued beyond its expiration date due to other commitments within the company. At the expiration of the contract, Oldsmobile had been working on a T182E3 model using high velocity ammunition. During this period of time the Air Force changed its ammunition requirements from low velocity to high velocity. This ammunition incorporated a projectile of increased high explosive capacity with a muzzle velocity of 3000 feet per second.

In October 1953, Buffalo Arms, Inc. was contracted for production of 3000 T182E3 weapons. Requirements for the use of this weapon in specific aircraft were deleted from the contract, causing a contract change during the early stages of this manufacturing program. The production program reverted to a research and development type program requiring manufacture of only 450 weapons. Under the direction of Springfield Armory, Buffalo Arms, Inc. intensified efforts to improve manufacturing techniques and methods which would eliminate weapon malfunctions attributable to manufacturing processes.

In July 1954, a Research and Development contract was placed with Ford Motor Company for the further development of this weapon. Ford, under direction of Springfield Armory, concentrated efforts on improvements in reliability and performance of the weapon using a high velocity round but with a heavier projectile than in earlier ammunition.

This new cartridge with a longer cartridge case, a heavier projectile and a different center of gravity, necessitated redesign of many gun components to meet the requirements of the ammunition and maintain reliability of the gun.

The T182 gun development program was seriously affected by major changes in ammunition as well as changes in mounting and feed requirements. Further complications were introduced by the unavoidable change in contractors, the premature commitment of the weapon to production, and the encumbrances attendant upon fabrication of a development weapon in limited quantities under the terms of a supply contract at Buffalo Arms, Inc.

The performance of the latest versions, the T182E4 1H and the T182E5 weapons, was reasonably good. With the exception of barrels which had to be changed every 1200 rounds, the weapon has a minimum life of 5000 rounds. This gun has a cyclic rate of 1200 to 1500 rounds per minute and was designed to function in climates that range from -70° F. to +140° F. Work ceased in 1957 on these guns, with only six T182 guns in existence as of 1969.

Description and Purpose

The 30mm automatic gun T182 is a gas-operated, belt fed, electrically fired, and utilizes a high velocity cartridge. The weapon may be assembled to feed from either side. The distinguishing feature of the gun is a drum assembly containing five cartridge chambers parallel to its axis of rotation and mounted on a shaft within the drum cradle. The drum assembly is rotated and indexed during cycling so that each chamber is brought, in turn, into alignment with the bore at the 6 o'clock position. It was originally intended for bomber tail defense.

The weapon was designed for transmission of the recoil forces through trunnions cast integrally with the steel barrel support which also houses the recoil springs.

Because of this arrangement just described, it was possible to design the receiver frame for minimum loads, and cast it from an aluminum alloy. At points where the receiver frame engages moving parts, steel ways or supporting members have been inserted. The receiver frame and barrel support assembly are held together with four studs and nuts. Alignment is attained by assembling the drum support on the receiver and inserting the barrel through the barrel support assembly into the drum support body followed by tightening and wiring of the nuts holding the barrel support assembly.

The barrel, 42.5 inches long, weighs 27.25 pounds and the total weight of the gun is 204.25 pounds, including the feeder and charger. The T182 is 61.7 inches long, 10.5 inches wide, 9.7 inches without the trunnions and 10.5 inches high.

Cycle of Operation and Mechanical Description

The operating slide assembly fits guide ways in the bottom of the receiver and moves backward and

Characteristics

Bore Size	30mm
Muzzle Velocity	3000 fps
Rate of Fire	1500 rpm
Basic Systems of Operation	Gas
Locking System	Other
Power Source Feed System	Gas
Feed System	Sprocket Type
Type of Feed (location)	Link
Method of Chambering	Ram
Type of Accelerator	None
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	U.S. Air Force
Manufacturer	Buffalo Arms
Ammunition Type	T204; T239
Overall:	
Length	61.7 in.
Width	10.5 in.
Height	10.5 in.
Weight	204.25 lb.
Barrel Dimensions:	
Length	42.5 in.
Weight	27.25 lbs.
Grooves:	
Number	16
Depth	.035 in.
Width	.145 + .008 in.
Twist	1 turn - 19.7 R.H.

forward beneath the drum and drum support under the action of the gas piston, drive springs and torque of drum with a stroke of five and one-half inches. Two cam paths, machined into the operating slide body, engage the rollers and cause the drum to rotate as the slide moves to the rear. The driving springs and inertia of the revolving drum acting through the rollers force the slide forward. These two cam paths consist of curved portions three and one-half inches long which curve in toward the longitudinal axis of the slide and merge into a central straight portion two inches long. A part of the inside edge of each cam path is formed by a movable member, called the operating slide switch assembly, which pivots about its forward end. The position of this tongue determines which cam path is made continuous throughout its length.

Firing occurs just as the operating slide reaches its battery position, and is initiated electrically by the engagement of a male contact on the side of the operating slide with a female switch on the side of the drum support near the rear. The operating slide is moved rearward by a piston which receives its energy from gases bled from the barrel into a cylinder in the front end of the drum support. The operating slide is returned to its forward or in battery position by interaction between the rotating drum rollers and the cam surface in the operating slide assisted by two drive springs (coiled wire). The slide has a slide switch tongue which pivots about a pin through its forward end to change the cam path. The tongue is moved from one side to the other during slide travel by a pin extending from the tongue which engages a switch cam in the bottom of the receiver. The switch cam is attached to the drum support by ears on the front end of the cam which engage a groove around the gas cylinder, and recoils with the drum support in slide ways which guide the slide.

When a right hand barrel is ready to fire, the slide is in its forward position, the slide switch tongue is on the left side, and a drum roller is engaged by the straight portion of the cam path at the rear end of the slide, which maintains alignment of the chamber with the bore. When the round is fired, the slide is driven rearward by the gas piston. The drum roller, in following the cam path to the right causes the drum to rotate in a counterclockwise direction, when looking from the receiver toward the muzzle. As the active roller emerges from the right side of the cam, the next roller enters the cam track on the left side and at the same time the slide tongue is cammed to the right by the switch cam. This permits the roller to move into the straight portion of the cam as the slide returns to its forward position. This brings the next chamber into alignment with the barrel. When the roller passes the rear end of the tongue, the tongue is cammed to its left position again.

In addition, the slide also actuates the extractor and the rammer which rams the rounds from the links into the chambers.

The forward section of the receiver houses the barrel, gas tube, barrel support assembly and recoil springs. The rear area of the receiver accommodates the feeder, drum support slide, and cam ways. Underneath the slide is a switch cam which engages a stud on the tongue or a spring-loaded pin within the stud. This cam is designed so as to cause the tongue to move from one side to the other at the proper time in the cycle. This changes the continuity of the cam path in the slide from one side to the other, and causes the drum to move in one direction on both the rearward and forward stroke of the slide. The straight portion of the slide cam keeps the drum stationary for the first two inches of its rearward travel. Thus, during the first two inches of slide travel, the chamber is aligned with the barrel while the projectile is in the bore. The empty cartridge case is at the extraction station during the last two inches of slide travel. Variable relative motion between the drum and switch and switch cam from round to round cannot be tolerated, as the tongue must be switched precisely at the proper position of the drum roller in the cam path. Therefore, since the drum is a recoiling part and since the recoil cycle does not follow a consistent pattern, it was necessary to make the switch cam a recoiling part. This was done by machining a groove on the outside of the gas cylinder portion of the drum support to engage ears machined in the front end of the switch cam.

The drum is machined from a forged steel billet. It contains five equally spaced chambers, with a gas seal at the front of each chamber. Sealing against gas leakage between the seal and the seal recess in the drum is accomplished by three piston rings in grooves around the seal. Gas pressure acting on the rear end of the seal and frictional forces in the seal, force the seal forward against the face of the barrel and prevent leakage of gas between the end of the drum and the rear face of the barrel.

The drum is mounted upon a shaft supported in the drum support and is keyed to it by an off-center dog machined on the rear end of the shaft. The shaft rotates with the drum and causes the feeder shaft to rotate with it by means of splines which mate and index the two shafts. A "U" shaped latch in the rear end of the drum support engages a groove in the rear section of the drum shaft and retains it.

The chamber in battery is held in alignment with the barrel during firing, and is indexed to bring the adjoining chamber in alignment with the barrel by means of five rollers on the periphery of the drum. These rollers are retained by snap rings and engage a cam track in the operating slide which reciprocates in ways along the bottom of the receiver. The rear end of the drum support houses the firing pin assembly which also serves as the anvil for supporting the cartridge case during firing. The firing pin assembly has been made small in order to provide for maximum strength in the rear end of the drum support. This is necessary because of the concentrated load imposed on the drum support by the gas pressure acting on the cartridge case.

The barrel is housed in a barrel support assembly attached to the front end of the receiver. The barrel is retained by interrupted threads and a latch which is part of the drum support assembly. When assembled to the receiver, the four lugs at the front end of the drum support intermesh with the four lugs in the rear end of the barrel support. The barrel is supported at two points, at the rear by a close fitting bore within the drum support and the front by a similar bore at the end of the barrel support.

Considerable force is exerted by the sealing sleeves on the rear end of the barrel. To resist this force as well as the forward frictional force of the projectile, six interrupted threads have been provided on the barrel which engage mating threads in the drum support. Leakage of gas from the barrel orifice between the barrel and the mating bore of the drum support has been minimized by machining six labyrinth grooves in the barrel, three on each side of the gas port. Leakage of gas past the gas piston is prevented by three piston rings in grooves around the piston.

The charging system consists of the percussion charger and the U-shaped gas line connecting the charger to the valve body which fits into the drum support in front of the gas piston. The charger is mounted in a bracket that is part of the receiver and is secured by a clamp and nut. When the charger is fired, a selector valve in the charger valve body moves to block off the gas port to the barrel preventing leakage. When the gun is fired the selector valve moves to close off the charger system and so prevents leakage. Since the valve body is part of the drum support assembly it is a recoiling part, whereas the charger itself is not.

The two coiled slide drive springs are of wire construction, held in position by guide rods which engage bayonet locks in the back of the receiver. The guide rods ride through holes in the spring seat extensions which are part of the operating slide assembly.

The gas cylinder which contains the gas piston for actuating the slide forms an integral part of the drum support. This permits bleeding gas from the barrel through a gas port leading directly from the barrel into the gas cylinder. Since the gas cylinder is a part of the drum support and as such part of the recoiling mass, the force exerted by the gas piston on the slide opposes the recoil force and reduces the load on the recoil springs by an amount dependent upon the size of the gas orifice.

The feeder is of a welded sheet metal construction. The feeder shaft is geared directly to the drum shaft and rotates with the drum.

The sprockets on the shaft position the round in the path of the rammer and maintain the rounds in alignment with the chambers of the drum. It also has a trough which directs the extracted cartridge away from the gun and a chute for delinked empty links.

The rammer consists of a dovetailed and pinned assembly which reciprocates in the slide guide ways. The rammer is attached to the rear end of the slide by the dovetail.

Ramming is accomplished in two stages by upper and lower ram surfaces. The rounds in the ammunition belt are maintained in alignment with the chambers in the drum by the feeder as the linked ammunition is forced through the feeder. Upon firing, the gas piston drives the slide rearward. On the forward or return stroke of the slide, the upper ramming face of the rammer engages the base of a cartridge and pushes it through the link and partially into the chamber. At the same time, the lower ramming face of the rammer contacts the base of the cartridge, which was partially rammed on the previous firing cycle, and completes chambering it. A round-antibackup latch prevents the round from bouncing back past the point at which the lower ram can pick it up. A spring loaded round retainer in the rear end of the drum support retains the rammed cartridge in the chamber. Simultaneously, the round which was completely chambered on the previous firing cycle moves into battery and contact with the firing pin.

The recoil springs are assembled to the gun in the form of a cartridge unit.

The recoil springs are housed in the barrel support assembly, one spring on each side of the barrel. Recoil and counterrecoil forces are transmitted to the springs by the recoil spring bolts. When assembled in the barrel support, the recoil spring bolts extend through the housing in the barrel support assembly and attach to the front end of the drum support.

Recoil spring retainers are forced against the collar of the recoil springs and lock into the barrel support assembly. These retainers position the springs against the rearward ends of the cylinders. In doing so they restrict free movement of the recoiling parts in either direction without compression of the springs. Thus the springs are double acting and limit the counterrecoil forces as well as the recoil forces.

The extractor, located in the rear end of the drum support, is kinematically one piece construction. As the slide returns to battery, a striker on the right side of the slide strikes a face of the lower end of the shaft, causing the shaft to rotate and allowing the slide to continue to battery. The extractor pawl is held in a retracted position after extracting the case until the slide moves rearward again. When the striker on the side of the slide clears the end of the extractor shaft, a torsion spring on the upper end of the extractor returns the latter to extraction position with the pawl against the face of the drum. The ratio of movement of the end of the extractor pawl to the movement of the point struck by the slide is approximately 1.64 to 1. Case extraction velocities are approximately 55 feet per second.

The connecting leads of the firing circuit are insulated with molded nylon to form integral units.

The two blades of a female switch and the insulated firing pin are connected in series to one side of the power receptacle when the female switch is engaged by the male contact. The other side of the power receptacle is connected to a sensing device. When the slide is in battery the male contact is pressed between the two blades of the female switch, which completes the circuit to the electric primer when it is in contact with the firing pin.

When external power is applied to the receptacle the gun fires automatically on successive rounds when the slide reaches battery position and brings the male contact on the slide into engagement with the stationary female switch.

The gun is mounted on a rigid structure which supports it at the trunnions, and at receiver mounting holes. The rear mounting must restrain the receiver in a vertical plane, and provide freedom of movement in a longitudinal plane so that the front trunnions take all of the longitudinal load. The mounting structure must be sufficiently rigid so that it does not deflect in torsion at either the front or rear mounting points.

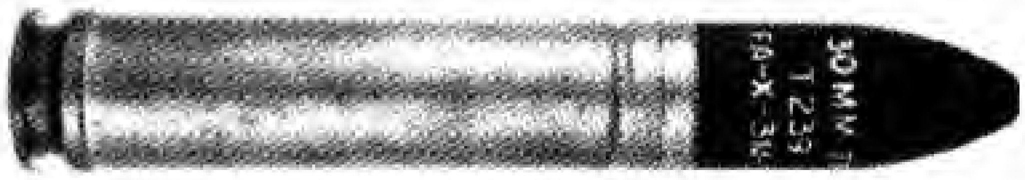
Test Results

According to final test reports: "The T182E4-1A model performed unsatisfactorily but with each succeeding model performance progressively improved. The T182E4-1H and T182E5 guns approached a reliable level of performance at the time development of the T182 gun was halted."

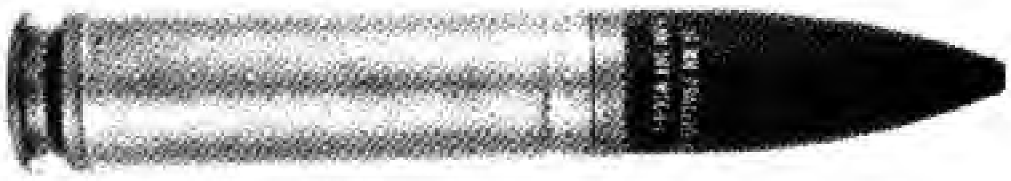
The report recommended: "Should the 30mm T182 revolver-gun project be revived, particular effort should be directed toward elimination of projectile fuze damage in chambering and obtaining a general increase in parts life."

Ammunition

The ammunition for the 30mm automatic gun, T182, are the T204 and the T239 projectiles. This ammunition incorporates a projectile of increased high explosive capacity with a muzzle velocity of 3000 feet-per-second.



30mm U.S., FAT15 Case (shorter). (Photo courtesy of Woodin Laboratories.)



30mm U.S., FAT15E1 Case. (Photo courtesy of Woodin Laboratories.)

Chapter 51

30mm T221 SHORT DRUM REVOLVER GUN

AMERICAN MACHINE & FOUNDRY

History

The original aim of the contract was the investigation of the T121/T182 30mm Revolver Gun to minimize or eliminate problems inherent in its design. The problems included the dynamic behavior and stress in components of the T121/T182 30mm revolver gun and the possible improvements in overall performance. Early investigations were mainly concerned with improvements in cyclic rate. To meet this goal, a nine-chamber twin barrel revolver gun was investigated. The methods of operation included a mechanism that was under the influence of gas pressure throughout its cycle and not dependent on energy storage in springs or rotating masses. It became apparent later that other concepts in revolver gun design would produce higher cyclic rates and alleviate most inherent design deficiencies in the T121/T182 30mm gun design.

This "new" concept, ultimately named "Short Drum Revolver Gun, T221," showed possibilities of improvements to revolver gun design. So the major effort was the development of such a weapon using T239 round ammunition.

Work on the contract began 1 August 1953 and concluded 31 May 1956. It was monitored by Springfield Armory.

During the development of the T221, the potential capabilities of such a weapon and its suitability for the Navy 30mm Magnum round were also investigated. A contract supplement for this work allowed an initial design, and a firing test fixture to study the extrusion and extraction problems which might be encountered. The results of the test firing program were conclusive in that no problem existed in these areas. At the conclusion of these test firings, the test fixture was shipped to the Naval Gun Factory, Washington, D.C.

Description and Purpose

The Gun, Automatic 30mm, T221 differs from the conventional revolver gun design in that it has a shortened revolver drum, dual gas operating cylinders and a moving breech or bolt. A dynamic test fixture was manufactured to test the principal weapon components of the Short Drum Revolver Gun T221.

The slide was given the final ramming task and the initial ramming is performed by the feeder.

This system, devised to secure the minimum slide stroke, made possible the use of a moving breech, or bolt, and a shortened revolver drum. In this system, the round is chambered partially in the drum and partially in the barrel. The bolt is secured to the drum during peak firing loads. The drum is keyed through an integral flange directly to the receiver.

The drum shaft is keyed to the drum with splines. To avoid energy loss during indexing from friction between the drum rim control and the recoil thrust flange of the receiver, the drum shaft has an extension to provide a calibrated spring which removes the drum rim from contact with the receiver flange after the peak firing thrust has been dissipated. The five chamber drum has a rear extension to provide locking teeth to secure the bolt during the peak firing load. The drum rollers are spring loaded to be operated in and out from the main cam track by means of the entrance and exit ramps. This design eliminated the need for the conventional switch track in the main slide.

The receiver consists of two sections, one steel and the other aluminum. The steel receiver (forward section) includes the barrel support, dual operating gas cylinders, recoil ways for the front trunnion, front drum support, and the drum rim flange. The aluminum receiver (rear section) contains the ways for the rear slide and main cam slide. It also contains exterior guides cast in aluminum for the drive springs. A steel tail gate was used to close off the rear end of the aluminum receiver, and also to support the drive spring guide rod plugs.

In the study of methods to increase the cyclic rate, the analysis of factors governing cyclic rate indicated that the total slide stroke and drum mass were of great importance. The short drum revolver gun, T221 design makes it possible to secure a minimum slide stroke. This system includes a shortened revolver drum and a moving breech or bolt. The bolt is secured to the drum during peak firing loads and serves as the anvil. A preliminary design of an ammunition feeder using a suitable existing ammunition link was also investigated. The Short Drum Revolver Gun design resulted in a reduction of overall dimension and weight. The following table gives dimensional and performance characteristics of the T221.

Characteristics

Bore Size	30mm
Muzzle Velocity	2950 fps
Rate of Fire	1600 rpm
Basic System of Operation	Gas
Power Source Feed System	Gas
Feed System	Sprocket Type
Type of Feed (Location)	Link
Method of Chambering	Ram
Type of Accelerator	None
Initial Extraction	Other
Type of Receiver	Machined
Weapon by Source	U.S. Army
Manufacturer	American Machine & Foundry Co.
Ammunition Type	T239
Gun Size:	
Length	59 in.
Width	8.38 in.
Height	8.38 in.
Weight	132 lb.
Barrel Weight	27.5 lbs.

A similar design of Short Drum Revolver Gun using the Navy 30mm Magnum round was also investigated and a test fixture was manufactured and test fired. The results indicated that no extrusion and extraction problems were present. However, the investigation was discontinued due to uncertainties in the ammunition development program.

The adaptation of the 30mm Short Drum Revolver Gun, T221 to fighter installations was investigated. The Short Drum Revolver Gun, T221 having smaller overall dimensions than M39 20mm gun, could be modified to meet the requirements for fighter installations in a manner comparable to the M39 20mm gun. This would require new feeder and link design so that the weapon could eject cases to the rear at a high speed.

Cycle of Operation

The slide assembly consists of a main slide and a rear slide. The main slide, after receiving an impulse from the gas pistons, moves to index the drum and simultaneously transmits its motion to the rear slide through the cross arms on the rear slide. These cross arms extend into the spring cavities in the aluminum receiver. Each set of springs contain an inner spring and an outer spring. These springs, oppositely wound, are made of stranded wires. The inner spring is guided on a steel rod and the outer spring in the aluminum receiver. The springs are so arranged that the inner spring acts on the main slide while the outer spring acts on the rear slide. During each cycle both slides are coupled together. Each time the slides return to the battery position, the two slides are decoupled by the cammed rotation of the couplers, (the slides at the battery position are disconnected). This is done to permit the charging operation.

As the rear slide is propelled rearward, it exerts a pull on the bolt through the parallelogram links. This pull forces the bolt to unlock itself vertically from the drum due to the motion of the bolt rollers in the cam tracks. The spent case under the influence of the residual gas pressure and the extractor, follows the bolt toward the rear and moves into the feed sprocket. Simultaneously the spent case is indexed into the ejection chute while another round of ammunition is indexed into the path of the forward motion of the bolt to be rammed into the battery position.

Test Results

The Short Drum Revolver Gun preliminary designs indicated that an improved weapon design has been produced. Consequently, a firing model including the principal mechanisms was manufactured. The first test firing was on a single shot basis. A relatively good performance was obtained despite inadequate testing facilities.

To fire short bursts, a temporary feeder was designed to accommodate three or four manually loaded rounds in a manner which simulated the actual operation of the weapon. This goal was attained in a relatively short time and the test results indicated that the functions of feeding, final ramming and extraction were being performed according to the original premises. No major variance from the expected results was found during the test program. A complete firing record of eighty rounds and time-displacement records are available.

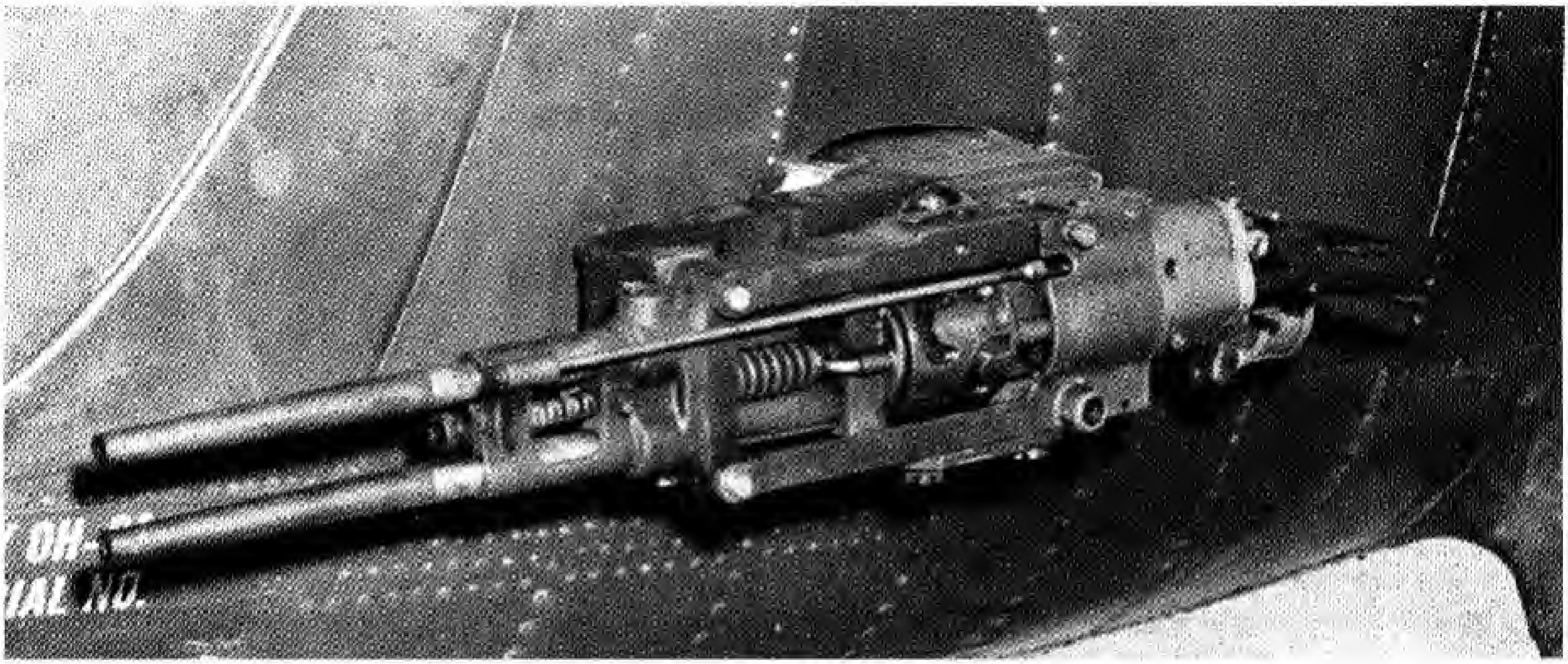
The test firing program furnished information on many factors which could not be evaluated solely from the theoretical analysis. Although promising results were obtained from the firing of the test gun, the usual program of redesign and modification of certain components would be required to bring the Short Drum Revolver Gun to true prototype status.

30mm T221 Ammunition (Photo courtesy of Woodin Laboratories.)

Chapter 52

7.62mm HELIGUN EX-17

HUGHES TOOL COMPANY (Presently McDonnell Douglas)



7.62mm Heligun EX-17

History

The 7.62mm Heligun was designed in 1963 by the Hughes Tool Company as a proprietary weapon incorporating the basic features of the Navy 20mm Mk XI gun. A prototype design fabricated with company funds fired approximately 100,000 rounds with burst lengths of up to 450 rounds.

This was followed by a contract from Dahlgren in 1965 to fabricate eight evaluation weapons and spares. Hughes continued to supplement the development of the Heligun. This included firing 125,000 rounds with the Navy weapons.

Hughes requested a contract extension to permit additional testing with 75,000 rounds to establish reliability levels and evaluate the functional areas causing weapon malfunctions. Design improvements were incorporated in the test weapons.

The gun was type classified EX-17 July 16, 1965. All work ceased in early 1968.

Description and Purpose

The EX-17 Heligun is a self-powered, high-rate-of-fire weapon chambered for the 7.62mm NATO cartridge. The maximum rate of fire is at least 6000 rounds per minute.

The gun is belt-fed, using the standard M13 link. Dual belts are used to feed the gun.

It is a percussion fired eight chamber revolver type gun with two barrels and an integral loader. Indexing of the revolver is accomplished by the recoil action. Direct acting gun gas is used to ram the rounds into the chambers.

The overall length is 30 inches, width 4.0 inches, and height 5.0 inches. The barrels are 13.6 inches long. The gun weighs about 30 pounds.

The operation is practically identical to the 20mm Mk XI aircraft gun.

Characteristics

Calibre	7.62mm (NATO round)
Weight	30 lb.
Length	30 in.
Height	5 in.
Width	4 in.
Rate of Fire	600 or 6000 spm
Time to Rate	Instantaneous
Action	8 chamber revolver
Operation	Recoil gas boost
Feed	Twin link belt (right- or left-hand)
Link	M13

Cycle of Operation

The Heligun operates on the Marquardt principle. When the trigger is pulled, the auxiliary firing pin is released and strikes the hammer which fires the cartridge in line with the lower barrel.

As the bullet passes the ram port five inches down the barrel, gun gas flows into the ram system through the gas manifold where it is divided with part flowing into the ejection system, ejecting any cartridge cases in the chambers in line with the ejection ports. The balance of the gas flows through the drive shaft to the distributor section, where it is split and flows to the appropriate sprocket cups. As the pressure builds in the sprocket cups, the cartridges contained are rammed into the chambers in line with the ram ports. Multifingered springs prevent the cartridges from bouncing out of the chambers.

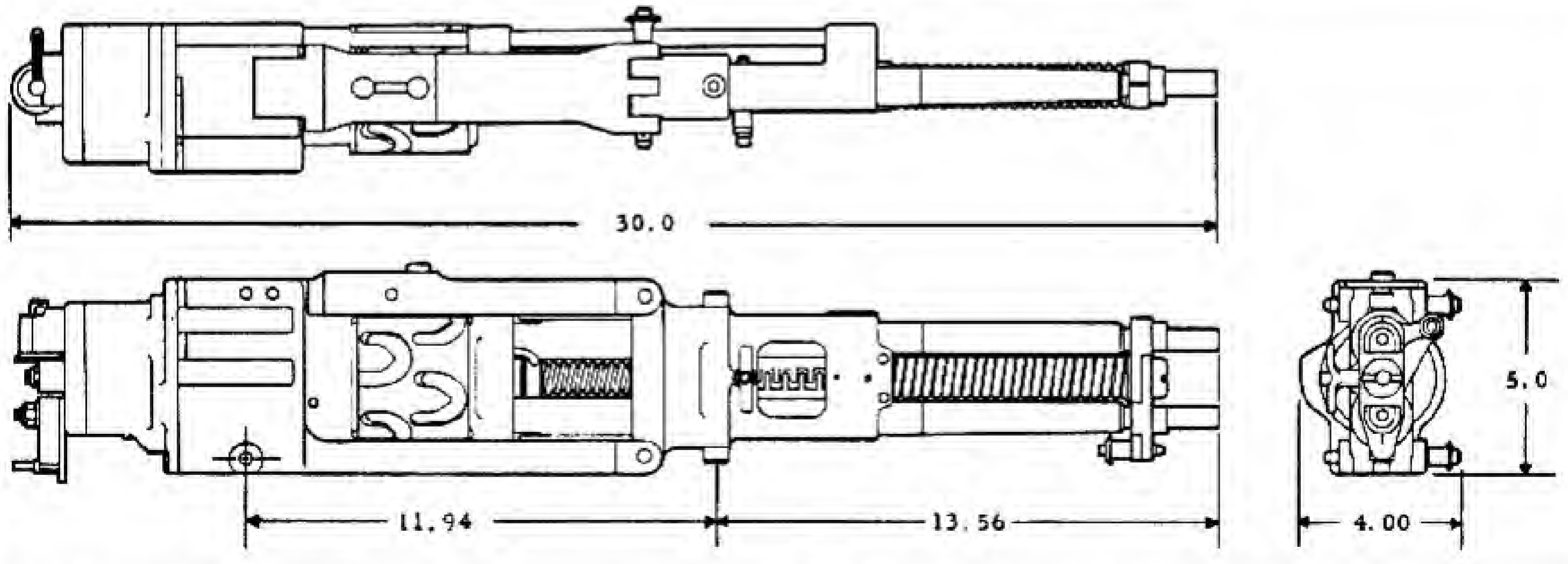
As the bullet in the lower barrel passes the firing system port, gas is admitted to the passage in the booster housing. It flows through the breech tube and the breech into the area behind the upper firing pin. As the pressure builds up, the pin is driven forward against the spring and fires the cartridge in line with the upper barrel.

As the two bullets travel through their respective barrels, the impulse is transmitted to the recoiling portion of the gun comprised of the cylinder, breech, barrels, and barrel locks. As the cylinder recoils, the cam follower in the receiver cover rotates the cylinder converting the recoil energy into rotational energy. When the action reaches the full recoil point, the recoil is stopped and the peak rotational speed is achieved. At this point, the cam follower reaches the counterrecoil part of the cam and the rotational energy is converted to counterrecoil force, causing the action to return to battery. As battery is reached, the slope at the end of the cam lifts the cam follower, in preparation for the next cycle.

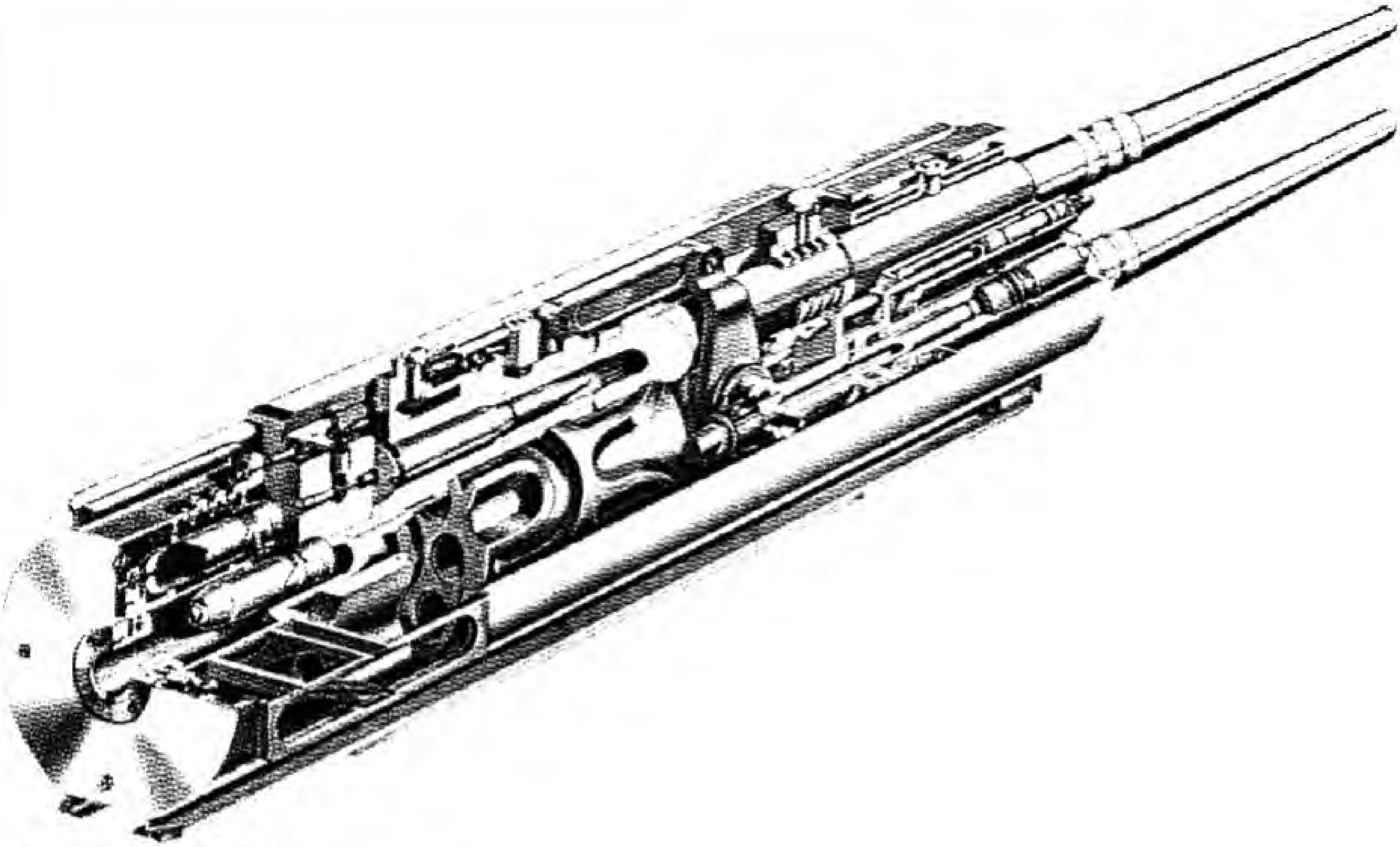
As the breech recoils, it pushes the auxiliary firing pin to the rear to a point beyond where the sear engages, leaving it cocked until needed to start the next burst.

As the bullet travels through the upper barrel, it passes a recoil booster port, admitting gun gas to the recoil booster cylinders surrounding the two barrels. Here the gas pressure acts upon piston shoulders on the barrels to augment the normal recoil energy. The boost used can be varied by changes of port diameter to adjust rate of fire or compensate for variations in mount rigidity.

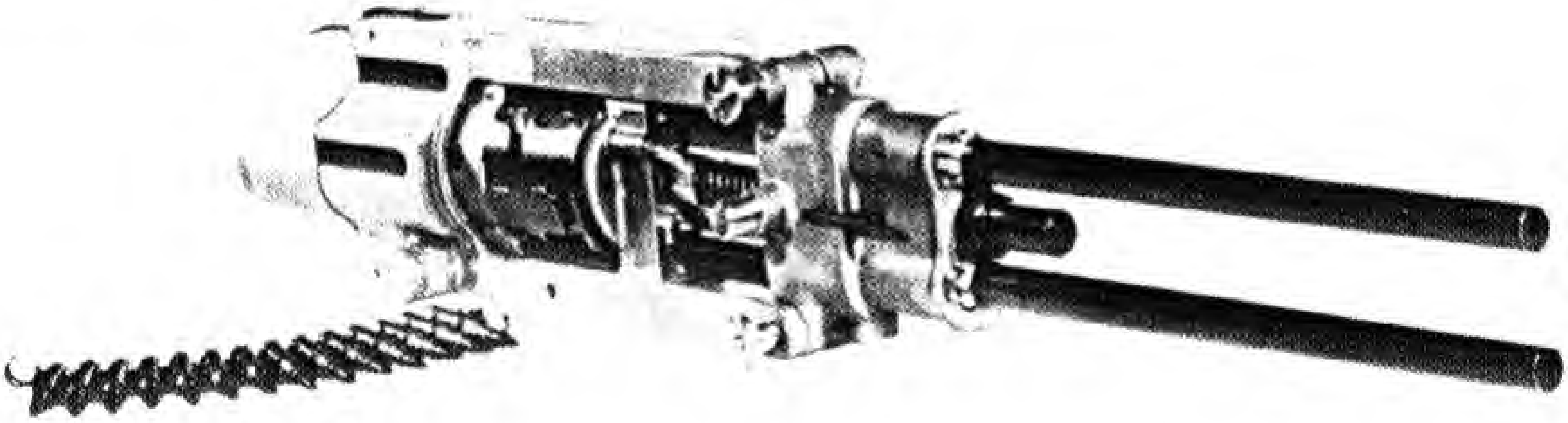
If the trigger is still depressed when the recoiling part of the gun approaches battery, the hammer



Hughes Heligun 7.62mm



20mm Mk 11 Mod 0 Machine Gun



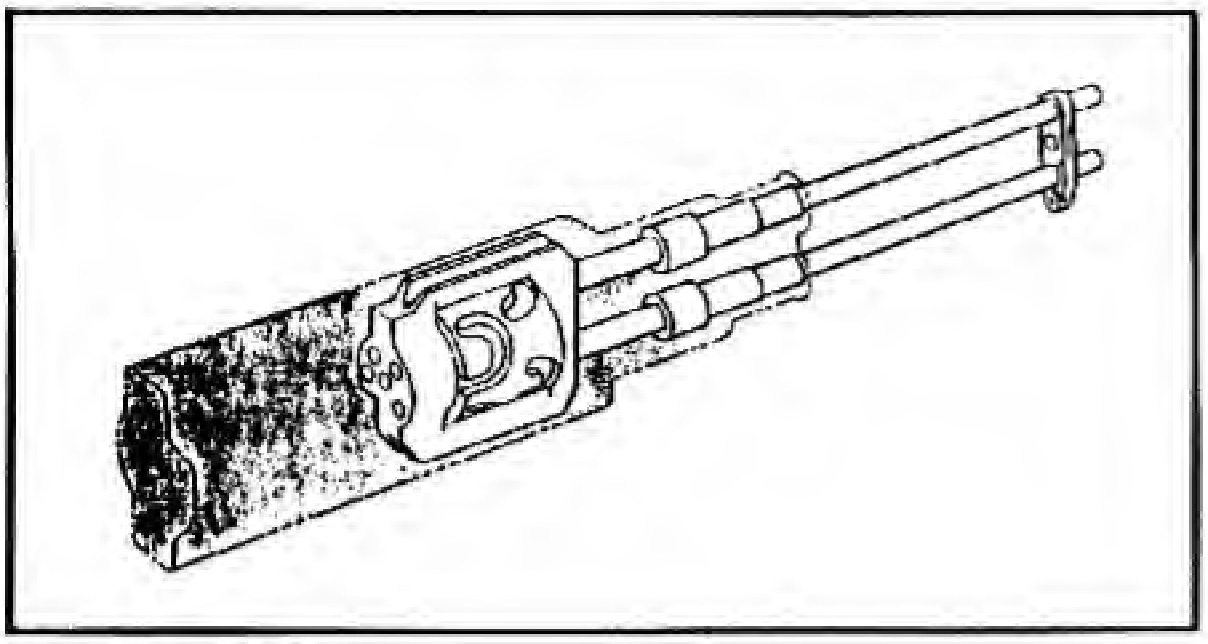
7.62mm Hughes Heligun

strikes the primer and fires the cartridge that was moved into alignment with the barrel during rotation. Firing proceeds as before.

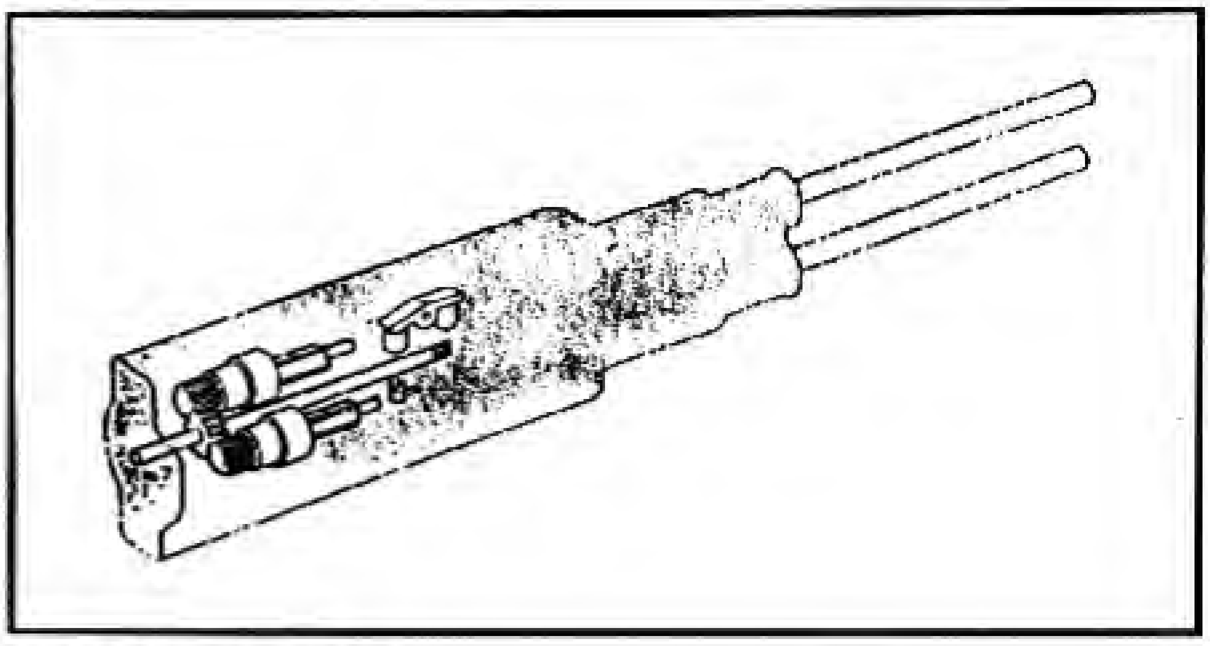
The incoming ammunition belts are engaged by the feed sprockets. The sprockets are driven by the drive shaft, which is driven by the rotation of the cylinder. As the breech recoils, it pushes appropriate cartridges to the rear, part way out of the belt, and into ram cups formed in the sprockets. Before the cartridge is rotated into the ram position, it is fully rammed into the cup in preparation for transfer to the cylinder.

When the trigger is released, the firing cam rotates to a position where the hammer tang cannot strike it. As the gun comes into battery, the round in the bottom chamber is not fired, and the gun stops. Two rounds are left in the cylinder, one in line with each barrel ready to start the next burst.

To clear the weapon, the clearing crank is turned 180 degrees which pulls the drive shaft spline out of



Recoiling Parts



Other Moving Parts

engagement and displaces the ram gas transfer ports. The gun is then fired or charged to clear it without ramming additional rounds into the cylinder. The gun can be rearmed by returning the clearing crank to the original position and charging.

Test Results

The overall conclusions of the 1967 tests conducted at the Naval Weapons Laboratory, Dahlgren are given below with minor editing.

Four Heliguns were selected at random and subjected to successive test firings and an evaluation of the functional areas causing weapon malfunction. A series of design improvements was incorporated in the test weapon to determine effects on functional reliability. A single weapon incorporating all of the developmental changes investigated during this period exhibited an increase in functional reliability from 300 MRBS to a final average reliability of 1750 MRBS.

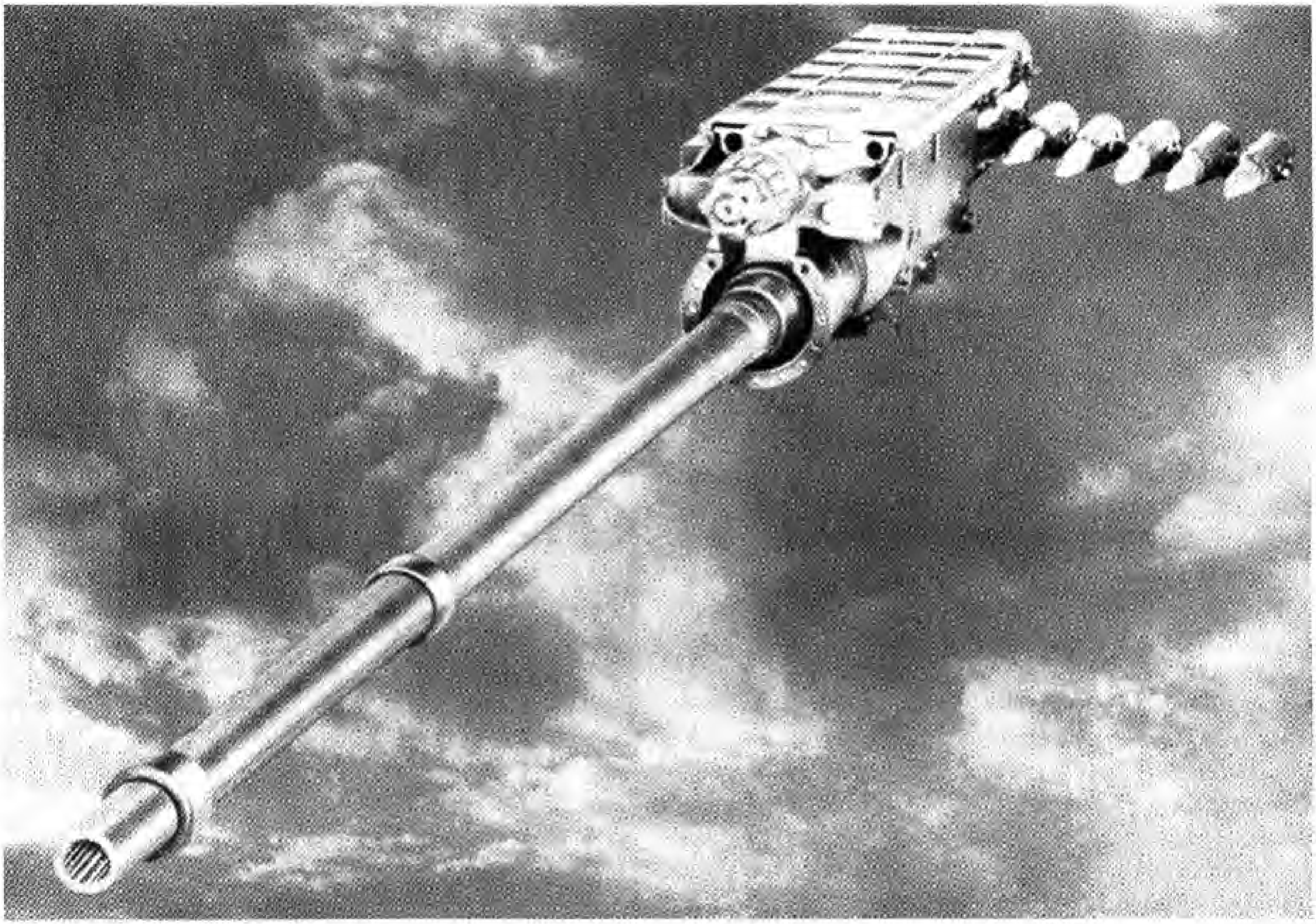
Solutions to several problems were effected by incorporating a new design of a dampened anti-bounce spring and a recoil buffing system that reduces peak loading to the gun mechanism. The investigations also revealed detrimental effects from thermal heating between the barrel and gas boost housing. Dimensional and design changes to these latter areas appear to provide a solution by eliminating part interference and drag resulting from repeated burst firings.

The remaining functional problem areas were identified and solutions proposed.

Chapter 53

30mm REVOLVER CANNON

OERLIKON KCA (Formerly 304Rk)



30mm Oerlikon Revolver Cannon

History

The design of the Oerlikon KCA is easily traced to the Mauser 213C. One of the Mauser design group, F. Linder, joined Oerlikon at the close of World War II.

The KCA represents the latest in a series of Oerlikon revolver cannons which include the 20mm 204Rk, the 20mm, 25mm, and 30mm 251Rk, and the 30mm 301Rk and 302Rk.

In the KCA (formerly the 304Rk) the weapon housing has been simplified so that the complete gun including the belt feed mechanism is free to recoil. The entire recoiling mass is controlled by buffer springs and supported by the front weapon bearing which is secured to the mounting structure.

The number of chambers in the revolver had been reduced from five to four, decreasing both size and weight.

The KCA was a primary candidate for the Tripartite MRCA aircraft and was tested by the Royal Aircraft Establishment of the United Kingdom in 1972. Eventually, Mauser designed and built a 27mm revolver cannon that was selected for the MRCA gun.

In November 1971, the United States Air Force contracted with Hughes to "Americanize" the Oerlikon KCA. This was done under a licensing agreement with Oerlikon. The work was completed in May 1973.

Description and Purpose

The Oerlikon KCA is a four chambered, single barrel, air cooled, link belt fed, gas operated, revolver cannon. The gun fires 1,350 rounds per minute at a muzzle velocity of 3,500 feet per second.

The KCA is 106 inches long, 8.5 inches wide, and 9.7 inches high. The gun weighs 263 pounds. The barrel is 89 inches long and weighs 53 pounds.

There are two important versions of the KCA; one made by Oerlikon, the KCA, and the other made by Hughes Helicopter, the GAU-9/A.

The main rationale for the KCA was to design and build the lightest weight possible high performance 30mm aircraft cannon. The gun is designed for aircraft usage only.

Cycle of Operation

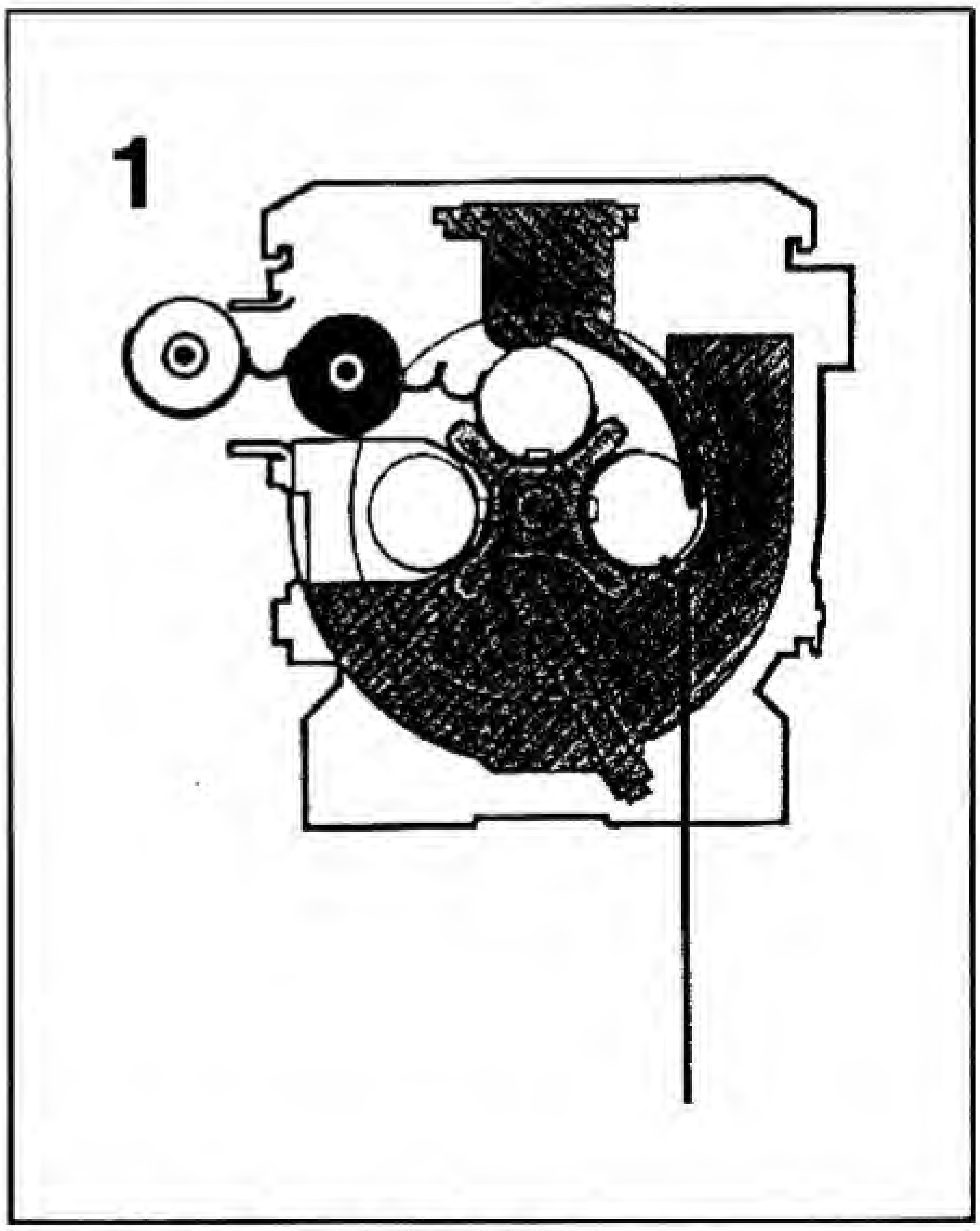
The functioning principles of the type KCA gun are as follows, a revolver cylinder placed to the rear of the gun barrel rotates about an axis parallel to the gun barrel. Its four cartridge chambers come into line with the barrel in succession. The rotation of the cylinder is accomplished by the movement of a gas-operated slide. The movement of this operating slide also causes the introduction of the cartridge into the revolver chamber.

When a chamber is in line with the barrel, the cartridge which it contains is in contact, via the primer fitted in its base, with an electric contact piece. The base of the case is supported by a solid portion integral with the gun barrel and forming a fixed breech. The current reaches the primer when the operating slide is in the rest position which corresponds with the locked position of the cylinder.

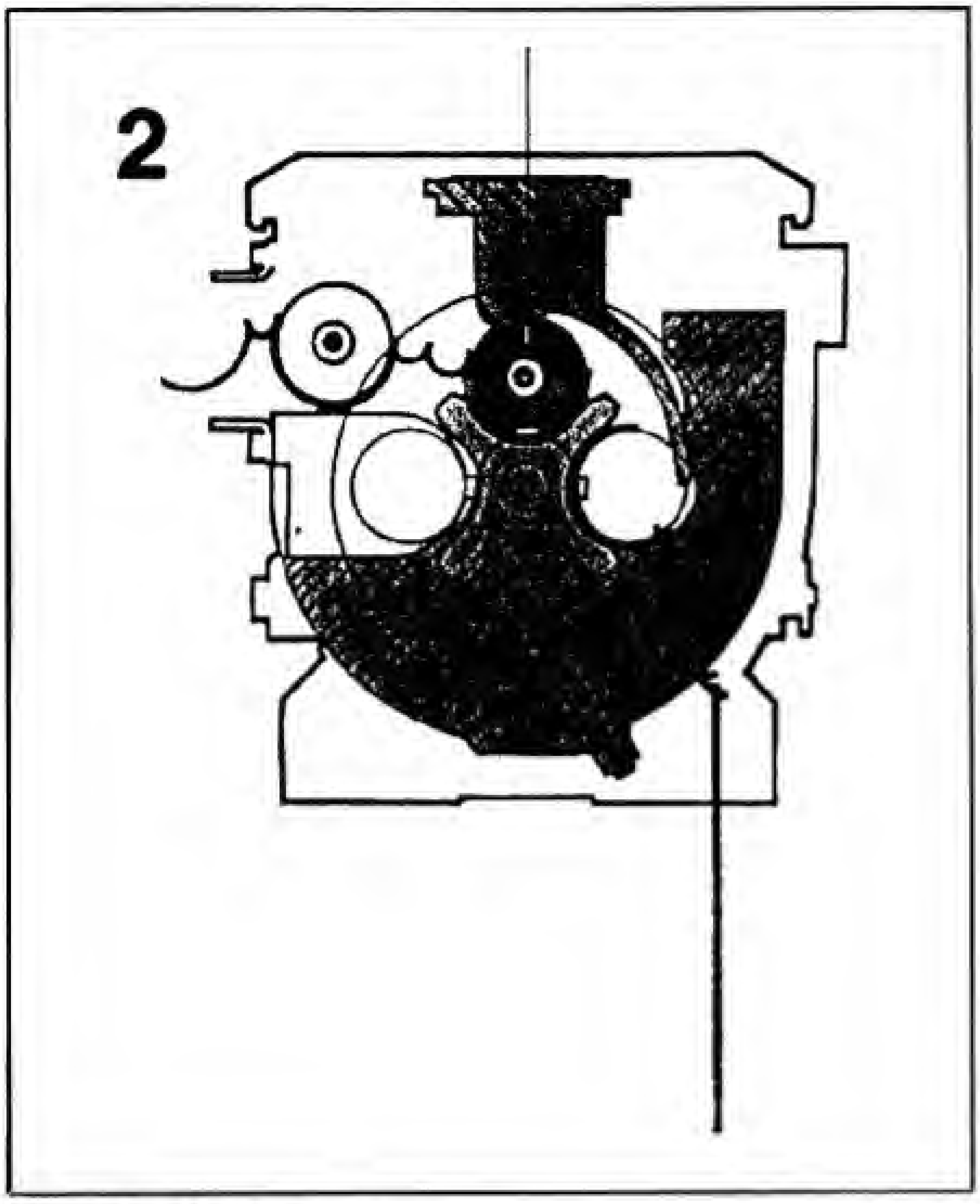
Characteristics

Calibre	30mm
Length of a Gun with Flash Reducer	106 in.
Length of Barrel	1976mm (78 in.)
Length of Cylinder	286mm (11.25 in.)
Length of Cartridge	290mm (11.4 in.)
Muzzle Velocity	3500 fps
Rate of Fire	1350 rpm
Weight of Gun	263 lbs.
Weight of Cartridge	835 gr. (1.85 lb.)
Weight of Cartridge with Belt Link	945 gr. (2.08 lb.)
Weight of Shell	300 gr. (0.66 lb.)
Mean Reaction Force on Mounting without Muzzle Brake	2000 kg. (4400 lbs.)
Mean Reaction Force on Mounting with Muzzle Brake	1700 kg. (3740 lbs.)
Frontal Area of 100 Belted Cartridges	0.325 m2 (3.5 sq. ft.)

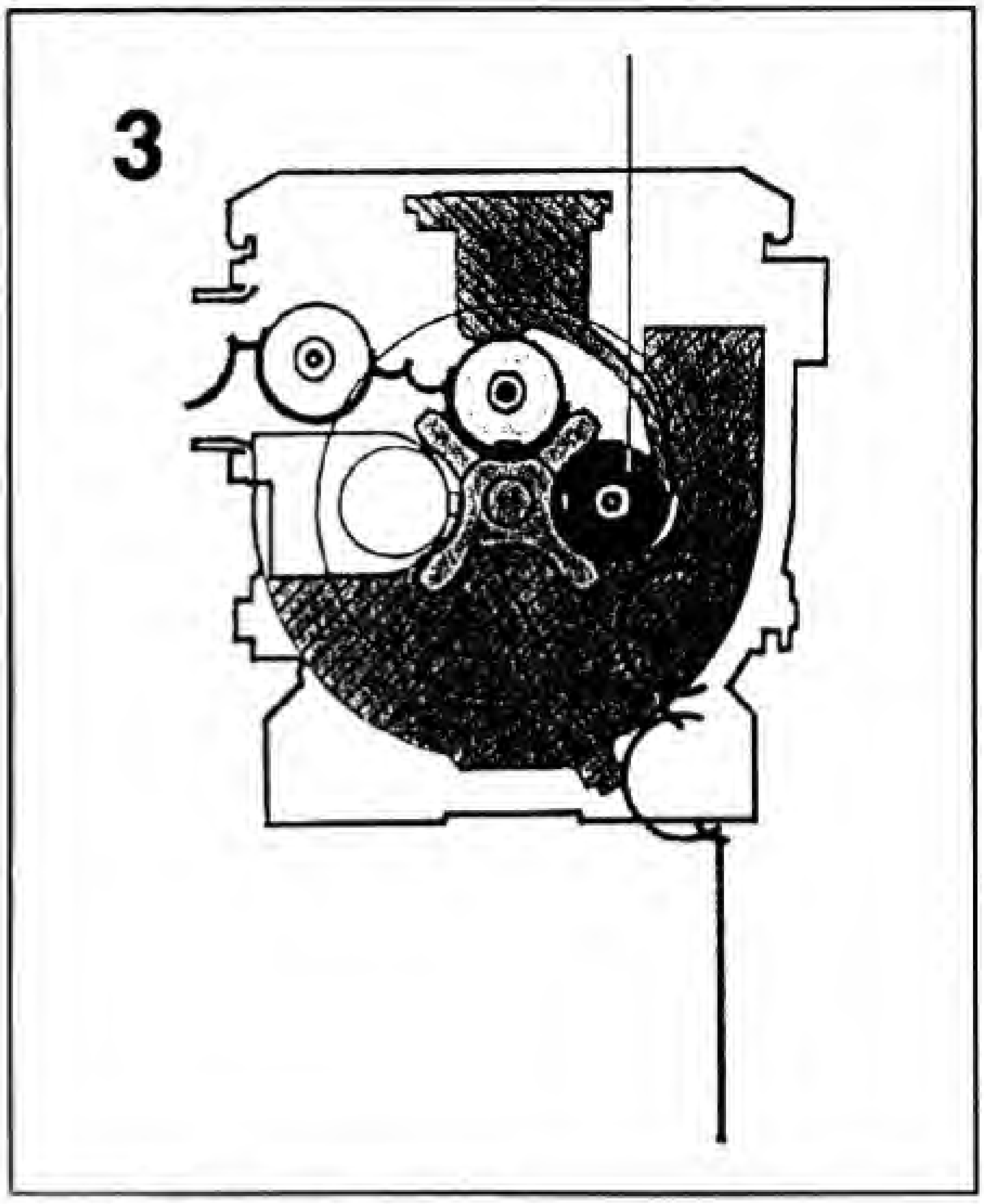
The round fires, the projectile leaves the revolver and enters the barrel where the driving-band engages with the rifling. The recoil takes place at this time.



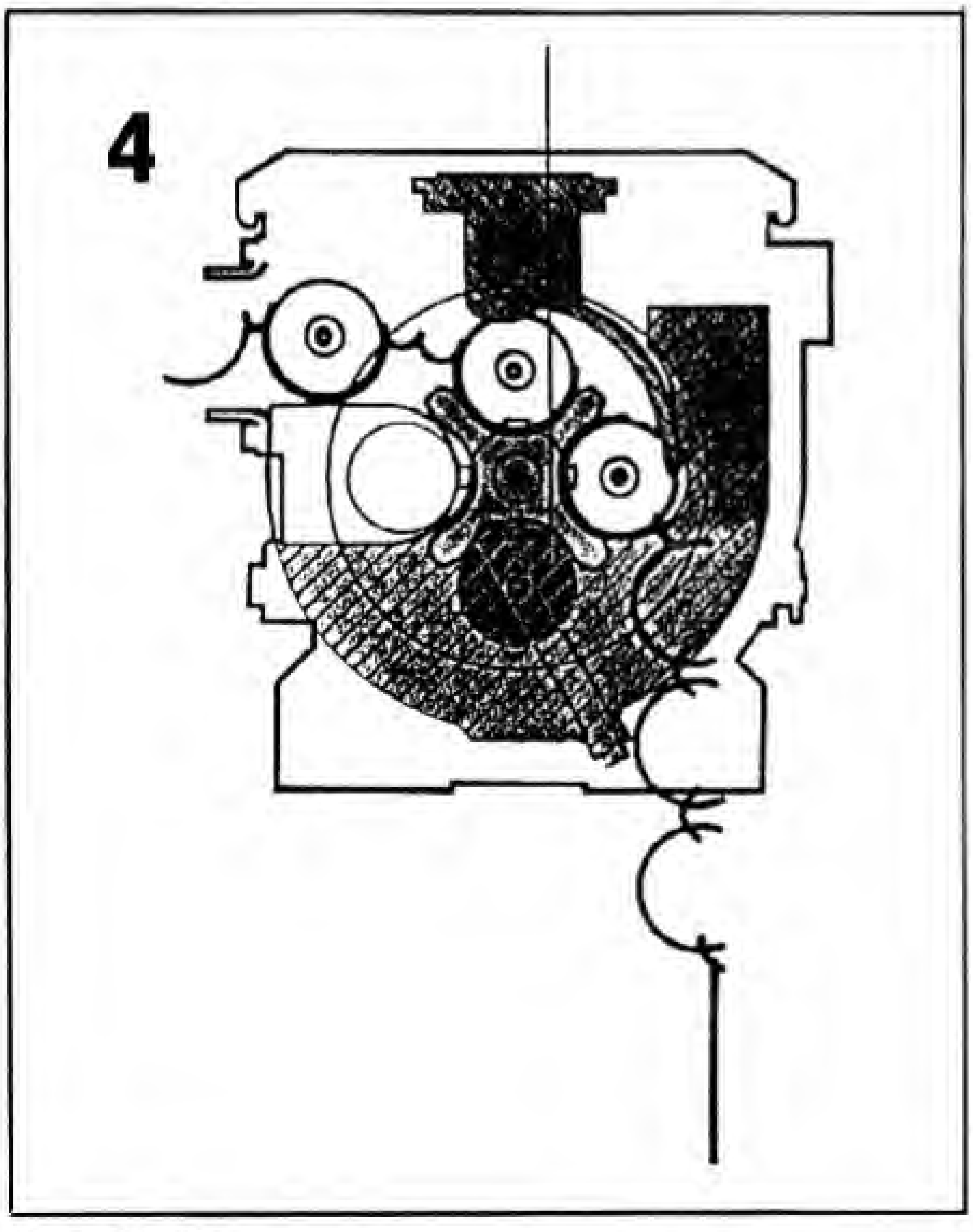
Cartridge Position in Revolver Drum



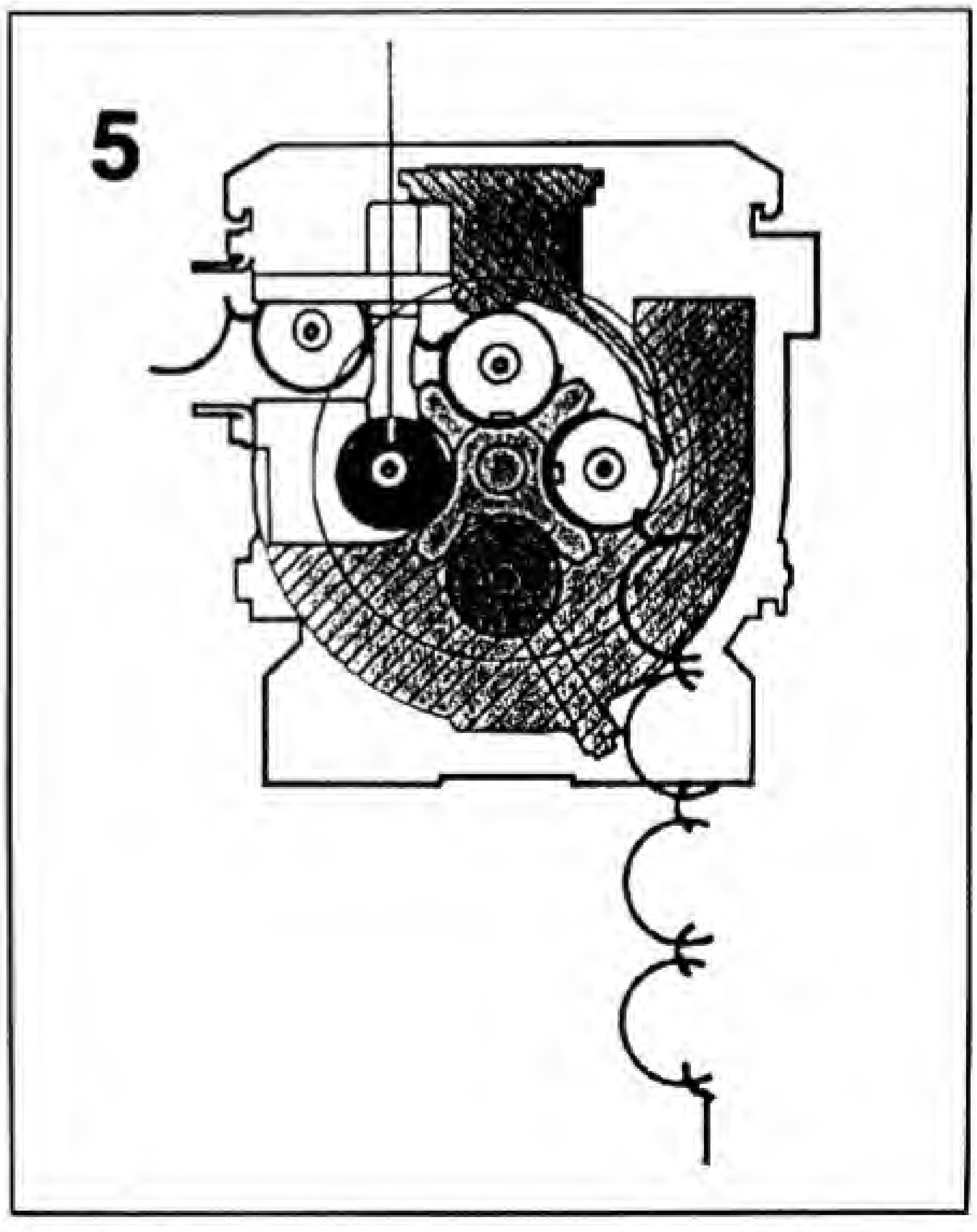
Cartridge Half Forward



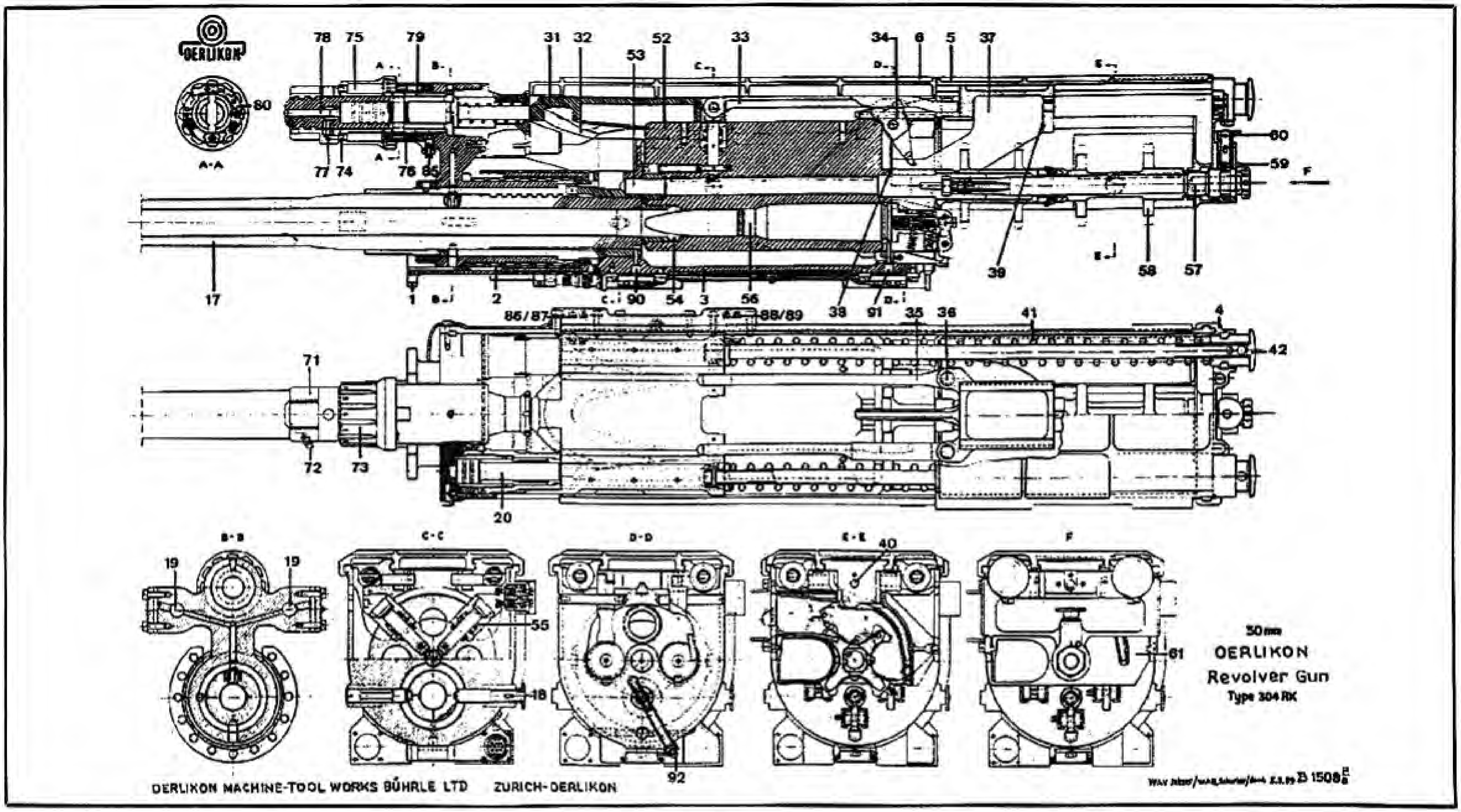
Cartridge in Chamber



Firing Position



Ejection


OERLIKON
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73
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B-B
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19
C-C
55
18
D-D
92
E-E
40
F
61
30mm
OERLIKON
Revolver Gun
Type 304 RK
OERLIKON MACHINE-TOOL WORKS BÜHRLE LTD ZURICH-OERLIKON
B 1508

Housing and Supporting:
1 Weapon Bearing
2 Buffer Springs
3 Weapon Housing
4 Back Plate
5 Rear Weapon Cover
6 Front Weapon Cover

Barrel and Gas Escape:
17 Barrel
18 Barrel Locking
19 Gas Vent
20 Gas Piston

Weapon Control
31 Front Part of Slide
32 Slide Curve
33 Control Rod
34 Ejector
35 Coupling Rod
36 Coupling Pin
37 Rear Part of Slide
38 Front Impact Surface
39 Rear Impact Surface
40 Tapped Hole
41 Return Springs
42 Grip Plate of the Slide Lock

Drum and Belt Feed
52 Drum
53 Sealing Sleeves
54 Locking Key
55 Switching Rollers
56 Cartridge Chamber
57 Feed Shaft
58 Feeding Star
59 Spring Bolt
60 Grip Disc with Locking Bolt
61 Belt Feed Box

Pyrotechnic Loading Device:
71 Locking Sleeve
72 Spring Pawl
73 Drum
74 Sealing Sleeve
75 Loading Cartridges
76 Slide with Firing Pin and Spring
77 Gas Vent
78 Gas Piston
79 Transporting Sleeve
80 Transport Pawl

Electrical System:
85 Contact for Pyrotechnic Loading Device *(1)
86 Sliding Contact for Loading (2)
87 Sliding Contact for Ignition (3)
88 Sliding Contact for Round Counter (4)
89 Sliding Contact for Loading and Single-Round Fire (5)
90 Double Contact (6) for Barrel Safety Device

91 Double Contact (7) for Monitor Lamp and Automatic Ejection of Misfires
92 Contact for Ignition

**( ) Numbers in Electrical Diagram*

On passing the gas-port, the propellant gas-pressure acts on two pistons which drive back the operating slide. As it goes back the operating slide causes the cylinder to turn through one eighth of a turn. Then the operating slide goes forward under the operation of its recuperator springs and the momentum of the cylinder.

The cycle starts again. While rotating, the revolver drives a shaft carrying four sprocked wheels into which the ammunition belt is engaged.

The empty links eject at the opposite side of the gun from the feed-entry, the cartridge cases eject rearwards parallel to the firing axis through the ejection chute on the feed-entry side.

The electric firing circuit is designed so that firing cannot take place if, the barrel is not in place, it is partly unlocked, the cartridge is not in the firing position, or the operation slide is not fully forward.

Test Results

Two test reports are available on the KCA revolver guns. One was an R.A.E. test (United Kingdom) to establish the gun's suitability for the MRCA aircraft and the other was an United States Air Force evaluation of the GAU-9/A system, the backup to the GAU-8/A weapons system for the A-10 aircraft armament.

The R.A.E. test was published in August 1972, but the actual tests were made during the first half of 1970. The tests conducted included measurements of gun kinematics and loads, gun recoil and runout loads, barrel radial loads, gun vertical and lateral loads, gun movement, rates of fire, accuracy, ejection velocities, muzzle velocities, blast pattern, gas concentration, and reliability. The No. 1 prototype gun was used throughout the tests and about 1325 rounds of ball ammunition were fired.

Results of the tests lead to the following conclusions, among others.

> "The gun behaves in a conventional manner for a revolver gun similar to the Aden and DEFA guns with improved design characteristics. The gun fired satisfactorily at the design rate of fire (1350 rpm) in all attitudes except inverted with 4.25mm gas port, but a 4.5mm port size may be required for inverted firing. Some increase in friction associated with inverted firing should be investigated by Oerlikon as a modification to the top covers may be required to alleviate it.
>
> Maximum belt pull was not investigated and this should be done at a later date with a representative installation feed. However, in the present trials a good belt pull under all conditions was indicated.
>
> The gun functioned satisfactorily at the design rate with standard aircraft.
>
> The gun fired sustained bursts (up to 64 rounds) without overheating, excessive wear or damage but it was not tested to the full gun specification for MRCA (100 round fire out).
>
> The rate of fire should not increase beyond the limits laid down in the gun specification as a result of sustained or intensive firing or other conditions.
>
> Results indicate that the gun should achieve the reliability and component lives laid down in the gun specification for MRCA in due course of development.
>
> No gun functioning defects or characteristics were revealed during these trials which would preclude satisfactory consideration for MRCA.
>
> The muzzle blast was high, about five times that of the Aden longitudinally and over twice laterally at a distance of 0.1 meters, but the differential decreases outward rapidly. Trials indicated, however, that representative radomes should sustain no damage or dialectric deterioration. . . .
>
> Measured gas concentrations were about three times those of an Aden gun. In the critical area of the empty case box the concentrations were, however, low.
>
> No gun installation defects or characteristics were revealed in the trials which would preclude satisfactory consideration for MRCA."

Ammunition

The Oerlikon Machine Tool Works manufactures a complete range of ammunition for 30mm automatic cannons.

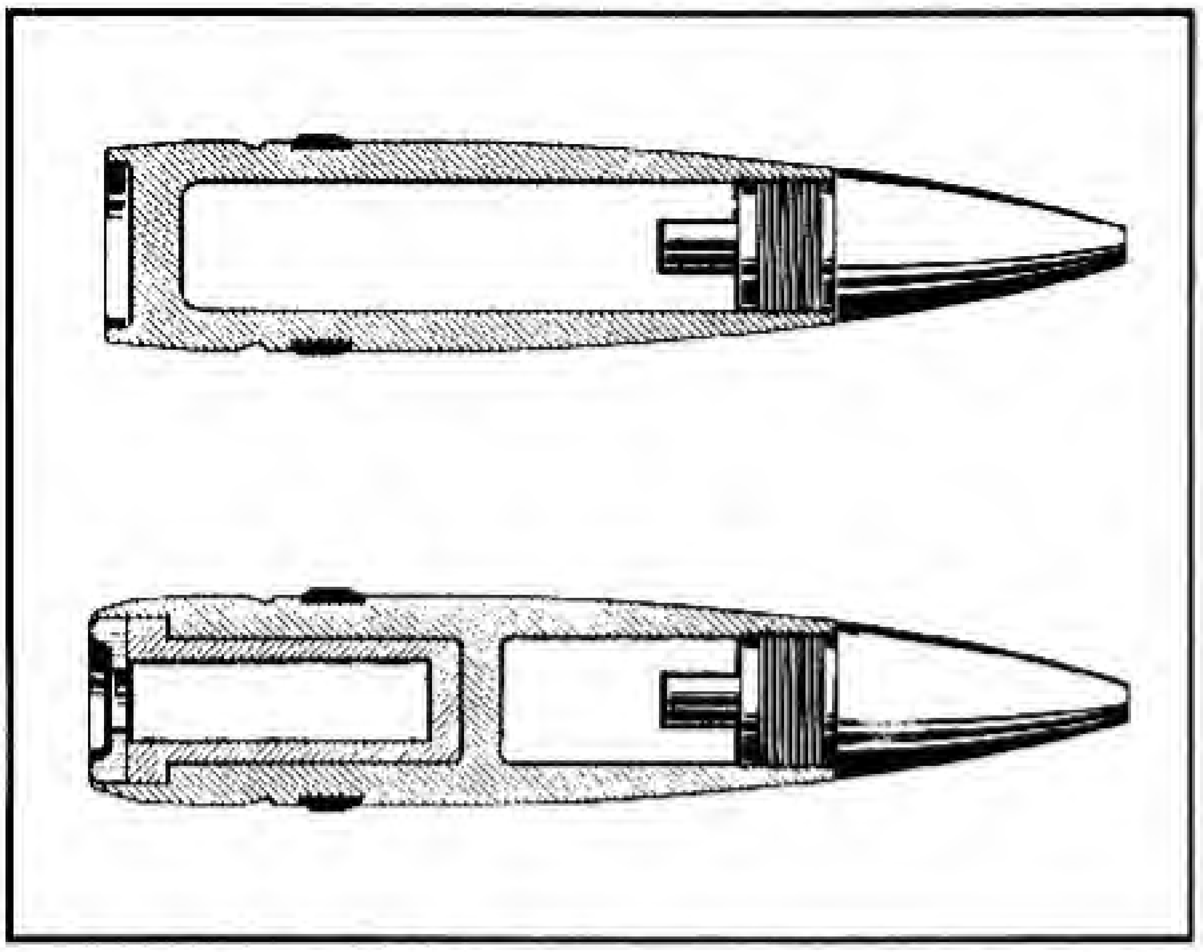
The 831-L type 30mm cartridges at present outclan all other existing types of ammunition of this calibre.

This range is composed of three categories:

HEI and HEI-T. With a high-explosive-incendiary shell filled having a powerful blast effect and fitted with a percussion fuze including a self-destruction mechanism. The HEI-T projectile is a HEI projectile provided with a tracer.

The type HEI projectile is a thin-walled shell of large high-explosive filling capacity. Its effectiveness lies mainly in its blast and its incendiary effect.

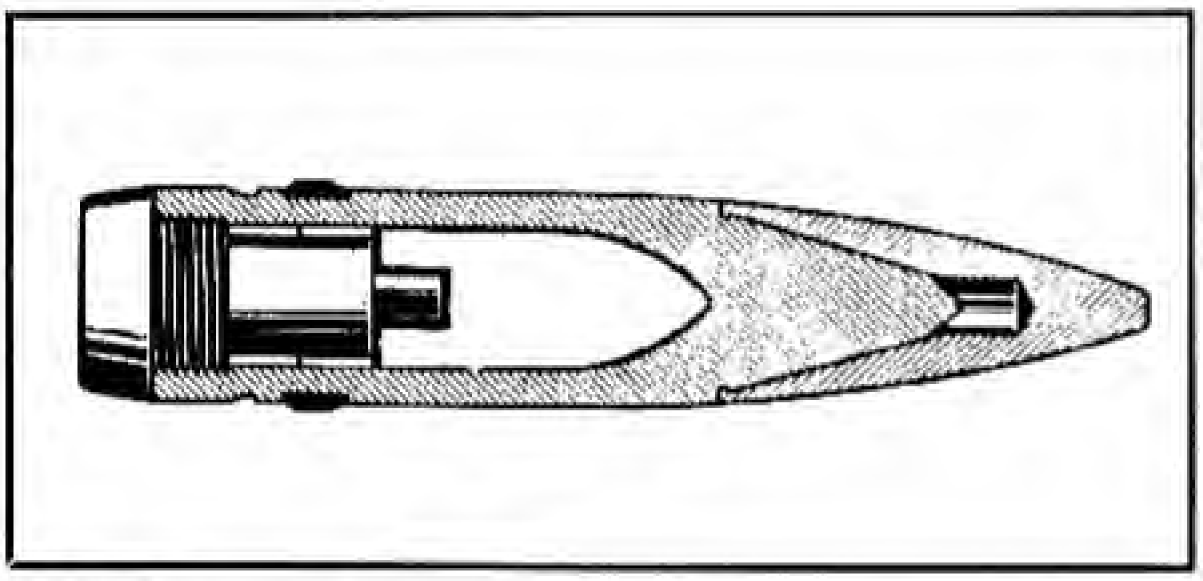
The sensitivity of the nose fuze guarantees the functioning of this ammunition even when striking at



HEI (top) and HEI-T (bottom) Ammunition

very low impact angles.

The type HEI-T projectile possesses, in addition, a tracer housed in the base of the shell body; this gives the opportunity to follow its trajectory.

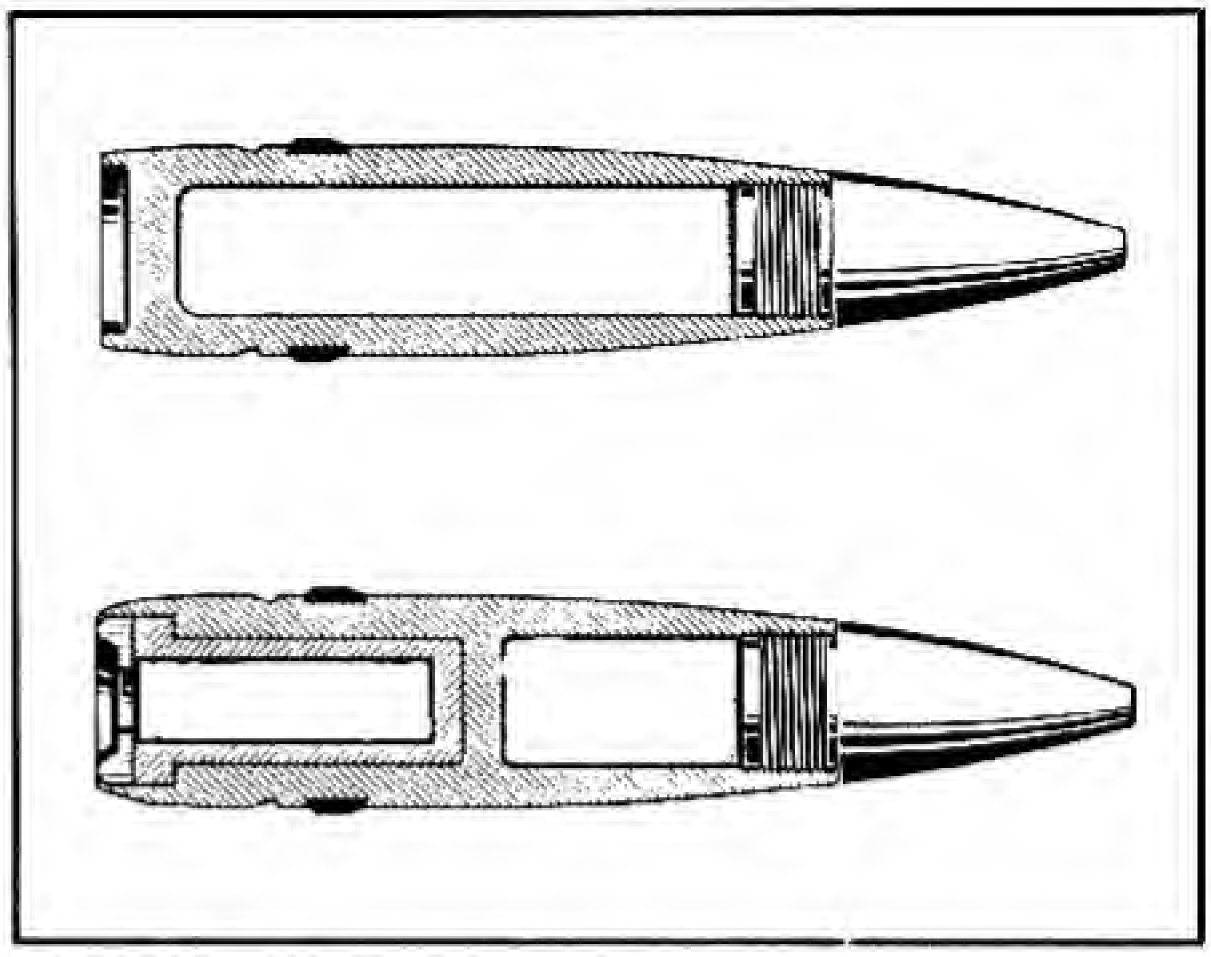


SAPI Ammunition

SAPI. With a semi-armour-piercing shell fitted with a percussion base-fuze including a self-destruction mechanism.

The type SAPI projectile has a pointed shell body and an explosive filling. Its shape gives excellent penetrating power. Its explosive filling causes fragmentation of the steel body as well as ensuring the incendiary effect.

This type of projectile is particularly designed for engagement against field defenses and lightly-armoured vehicles.



TP (top) and TP-T (bottom) Ammunition

TP and TP-T. With shell filled with an inert composition and fitted with a dummy fuze. The TP-T projectile is a TP projectile the same provided with a tracer.

This ammunition, which has similar ballistics as those of the service ammuniution, is used for training.

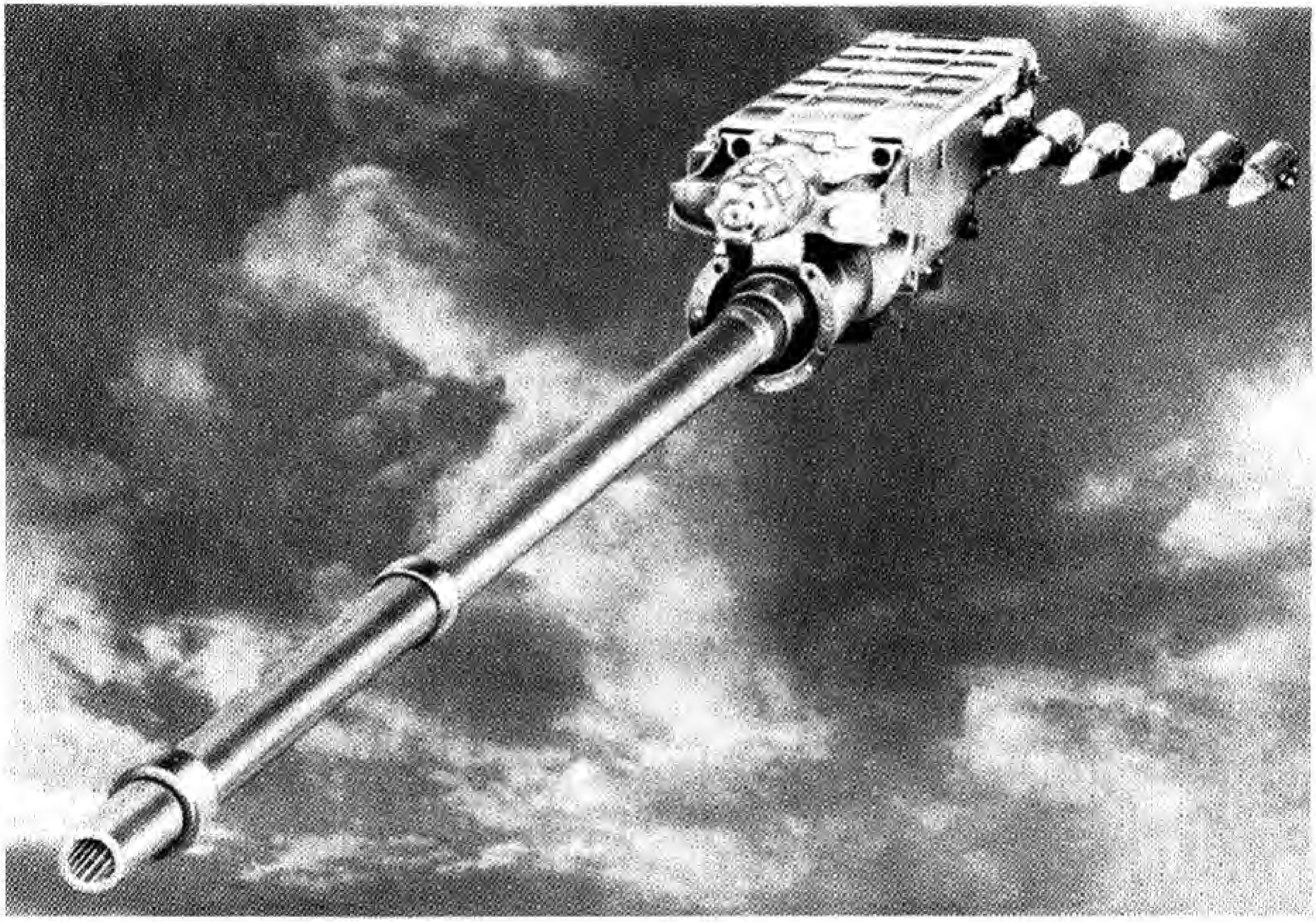
The TP-T type projectiles have dark ignition tracers which make it possible to follow their trajectory without dazzle.

Oerlikon KCA 30mm Ammunition (Photo courtesy of Woodin Laboratories.)

SECTION I.

30mm GAU-9 AIRCRAFT GUN SYSTEM

HUGHES TOOL COMPANY (Presently McDonnell Douglas)



GAU-9 Weapon System

History

Sparked by DOD interest in "already developed" foreign guns, the U.S. Air Force contracted with Hughes to provide a gun system incorporating two 30mm 304Rk Oerlikon aircraft guns capable of firing aluminum cased Oerlikon ammunition.

Hughes first became involved in this program through its unsuccessful proposal effort on the GAU-8 Close Air Support Gun program. Following the selection of prototype GAU-8 competitors, the Air Force Armament Laboratory, Eglin Air Force Base, contracted with Hughes to adapt European gun technology in the form of the 30mm 304Rk Oerlikon gun to a gun system representative of a typical A-10 aircraft installation. All program objectives were met. During the course of the development program at Hughes and the test phase at Eglin Air Force Base, approximately 35,000 rounds were fired without serious problems. Gun function was very good in that the GAU-9 gun is basically a simple, reliable mechanism. Weapon shortcomings were confined to the area of component life and all components which lack sufficient durability can be improved by the use of American materials and/or by minor design changes. As a part of the program, Hughes modified the Oerlikon guns by replacing the cartridge charging mechanism with a pneumatic charger and added a pneumatic-actuated clearing mechanism. These modifications allow the gun to be operated in the clear mode for takeoff and landing, a requirement for all United States Air Force aircraft.

Description

The GAU-9 Gun System tested under this program utilized two proprietary Oerlikon 304Rk Guns. When produced, the KCA version (rather than the 304Rk) of the gun would be manufactured. The two versions are substantially identical, except for some producibility and maintainability modifications.

In the gun evaluation and development portion of this program, the contractor quickly recognized that the basic 304Rk gun was not, as delivered from Europe, optimized for American usage. The contractor therefore undertook a number of gun improvement tasks which, although not required by contract, were needed to give the United States Air Force the most appropriate system for evaluation.

The gun which is a proprietary product of Oerlikon-Buhrle, Zurich, Switzerland, is a gas-operated, single-barrel, revolver cannon which has an instantaneous rate of fire of 1350 rpm. The ammunition used is the 30mm KCA Oerlikon round produced under license by Amron Corporation, Waukesha, Wisconsin. However, any geometrically similar round may be utilized.

Cycle of Operation

The weapon housing (receiver) of the GAU-9, together with the feeder box, revolver, and barrel, is free to recoil and is supported at its front end with the recoil/counterrecoil system and at the aft end with two fixed keys. Utilization of the entire mass of the gun in a recoiling mode effectively reduces the loads transmitted to the mounting structure.

The four-chamber revolver is fed by means of a rammer, operating through a slot in the feeder box, which is attached through two connecting rods to the operating slide. The slide, containing a semieliptical cam groove, rotates the revolver 90 degrees each time it cycles through its 7.652 inch stroke and returns. Power to cycle the slide is furnished by two gas pistons which receive their energy from a gas port in the barrel. The pneumatic charging unit also acts against the slide for the air charging operation. The slide is returned to the forward position by two main drive springs.

A simple shaft, with a single key, mounts the revolver and provides a rotational axis. As the revolver rotates, the rotation is transmitted through the revolver shaft into the feeder shaft and hence into the feeder sprocket. The feeder sprocket is split so that the two forward sprocket wheels can be rotated independently of the two aft sprocket wheels for clearing. Rotation of the feeder sprocket powers the movement of the ammunition conveyor through the gun.

Multi-stage ramming is used to introduce the rounds into the revolver chamber. In the initial (12 o'clock) position, the first round is rammed halfway into the chamber. In the second position, 9 o'clock is a right-hand gun, the first round ramming is completed. Simultaneously, the second round is half-rammed. The third (6 o'clock) position is the firing position. A partition in the weapon housing provides a nonmoving breeching surface for the round.

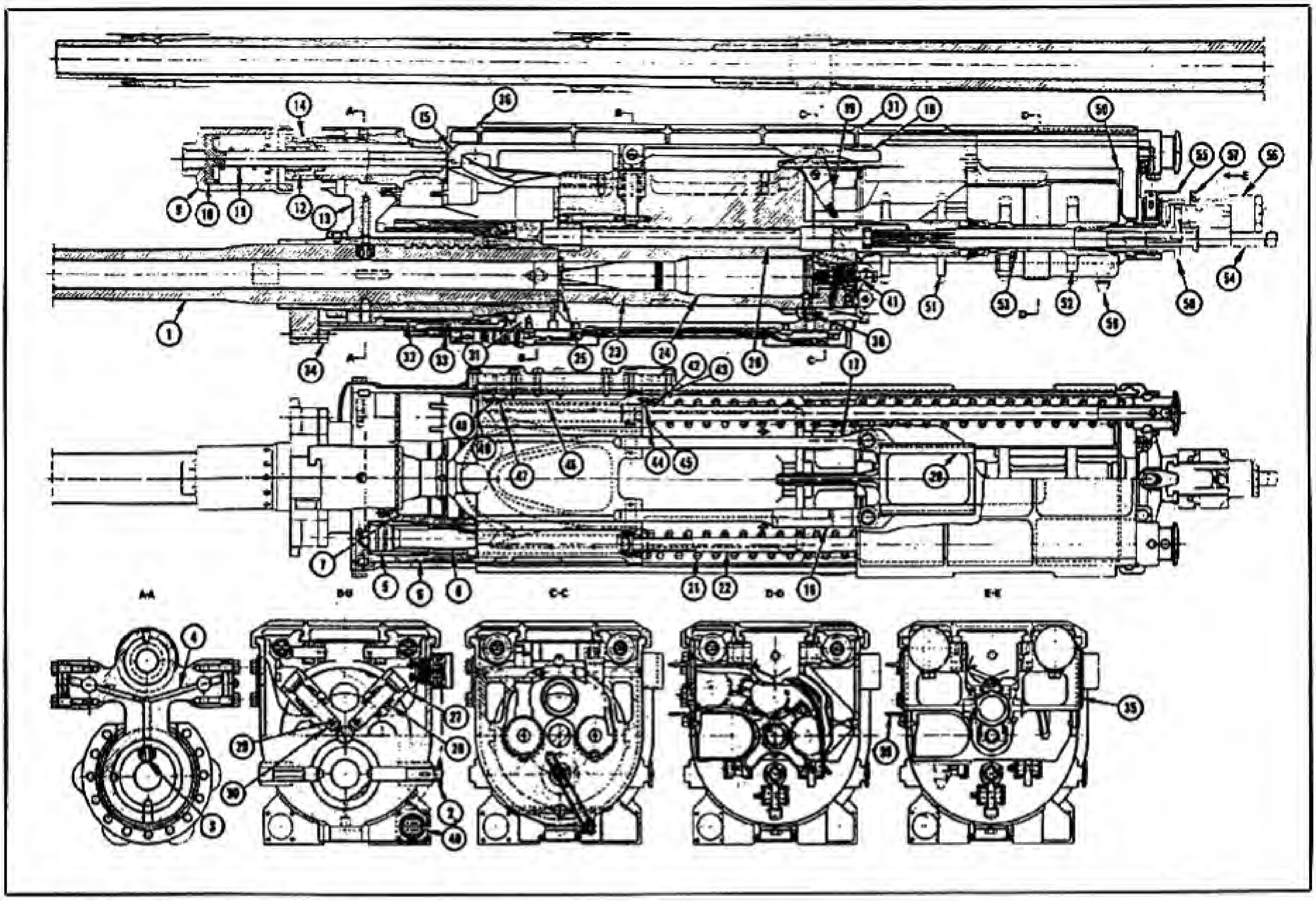
After the round fires, the gun gas tapped from the barrel cycles the gun. During this cycle the fired case is brought to the eject position where it is propelled from the back of the gun at approximately 75 fps by a mechanical ejector operated by one of the slide/rammer connnecting rods.

Control of the gun is electrical through a control box mounted on the gun pallet.

Recoil and Counterrecoil. Edgewater (ring) springs to react both recoil and counterrecoil loads are an integral part of the GAU-9 design. Preliminary gun

Characteristics

Calibre	30mm
Barrel Length including Revolver	89 in.
Barrel Weight	53 lb.
Muzzle Velocity	3415 ft/sec
Rate of Fire	1350 rnds/min
Weapon Length (overall)	106 in.
Weapon Weight	263 lb.
Round Weight (aluminum case)	1.4 lb.
Control Voltage	24 vdc nominal
Case Ejection Velocity	75 ft/sec
Maximum Belt Pull by Gun	1574 lb.
Average Recoil	8000 lb.
Maximum Ram Velocity	33 ft/sec
Automatic Dud Rejection Time	110 ms
Working Chamber Pressure	58,000 psi



Revolver Gun Parts Breakdown

Barrel and Gas Operating Assembly
1. Barrel
2. Barrel Lock
3. Barrel Port
4. Gas Passage
5. Gas Piston
6. Gas Piston Housing
7. Gas Piston Housing Lock
8. Gas Piston Buffer Springs

Pneumatic Charger Assembly
9. Pneumatic Charger Housing
10. Charger Piston
11. Piston Return Spring
12. Charger Coupling
13. Gas Bracket Manifold
14. Charger Sleeve

Slide Assembly
15. Operating Slide
16. Eject Operating Rod
17. Connecting Rod
18. Connecting Rod Pin
19. Ejector
20. Rammer
21. Drive Spring
22. Drive Spring Guide

Revolver Cylinder Assembly
23. Revolver Cylinder
24. Chamber
25. Ring Seal
26. Cylinder Shaft
27. Cam Follower
28. Cam Follower Springs
29. Lock Pin
30. Guide Pin

Receiver Assembly
31. Receiver
32. Inner - Recoil Buffer Spring
33. Outer - Counterrecoil Buffer Spring
34. Mounting Flange
35. Back Plate
36. Forward Cover
37. Rear Cover
38. Round In Chamber Switch
39. Feed Chute Mounting Bracket
40. Main Electrical Connector

Firing Pin Assembly
41. Firing Pin Group

Electrical Contact Assembly
42. Ground Contact (Upper)
43. Aft Charging Holding Circuit Contact (Lower)
44. Rounds Counter Contact (Upper)
45. Forward Charge Holding Circuit Contact (Lower)
46. Firing Voltage Contact
47. Aft Charging Circuit Contact
48. Forward Charging Circuit Contact (Lower)
49. Firing Voltage Contact

Feed and Declutch Assembly
50. Feeder Housing
51. Forward Feed Sprocket
52. Aft Feed Sprocket
53. Feed Shaft
54. Output Shaft
55. Cam Lock
56. Declutch Actuator
57. Declutch Actuator Latch
58. Declutch Sleeve
59. Eject Tube Locking Stud

mounts were designed and fabricated in order to determine the reaction loads under burst firing conditions. These mounts incorporated a strain gage link system to measure the loads. The loads measured were in agreement with those determined by the Ministry of Technology Weapons Department, Farnborough, England, and data supplied by Oerlikon from its own tests. Recoil loads, which were measured against the very hard stand (stiffness in excess of 200,000 pounds per inch), are 800 pounds peak (first round) and 8000 pounds (average peaks of subsequent rounds). The average recoil obtained by numerical integration of the recoil force is 2800 pounds. Counterrecoil peaks average 1500 pounds during the burst. The ring springs need no auxiliary damping devices. Both the recoil and counterrecoil loads are taken into the pallet and then to the aircraft structure through a bayonet mounting flange concentric with the barrel. The load path is extremely short and direct while the mount provides for simple dismounting of the gun.

Pneumatic Charger. The 304Rk gun was equipped with a pyrotechnic charging device when the guns were delivered from Oerlikon. The contractor, recognizing the problems which could be associated with its use, designed a pneumatic charger feature. The charger is supplied with air from the pallet system and cycles the gun for initial charging, autocharging of dud rounds if necessary, clearing, and recharging if desired. The pneumatic supply contains air enough for more than 200 charges. The pneumatic charging unit has been used throughout the entire U.S. test program and has proven highly reliable.

Declutching Feeder. The GAU-9 gun is equipped with an integral feeder which contains a declutching mechanism designed and fabricated by the contractor and demonstrated during the Eglin tests. European usage of aircraft guns permits takeoffs and landings with loaded guns. To comply with U.S. practice, the declutching feature allows clearing of the gun at any time, either by firing or by air charging. The feeder consists of a simple box with plate surfaces providing close control of the rounds. In the central core of the feeder, a four-tooth feeder sprocket engages the rounds and the conveyor elements to complete the round guidance provisions. This feeder sprocket is rotated by the gun's main shaft which, in turn, is rotated by the revolver during the gun's cycle. The declutch mechanism is pneumatically actuated through the use of a small air-operated piston.

Actuating the declutch mechanism disengages the aft ammunition feed sprocket and the output shaft from the revolver cylinder. This stops the ammunition belt feed and permits cycling of the gun to eject rounds remaining in the cylinder. When deactivated, the feed and declutch assembly again engages the ammunition drive to permit the gun to be recharged if and when desired. The pneumatic system for declutching is manually controlled for loading and electrically controlled for clearing.

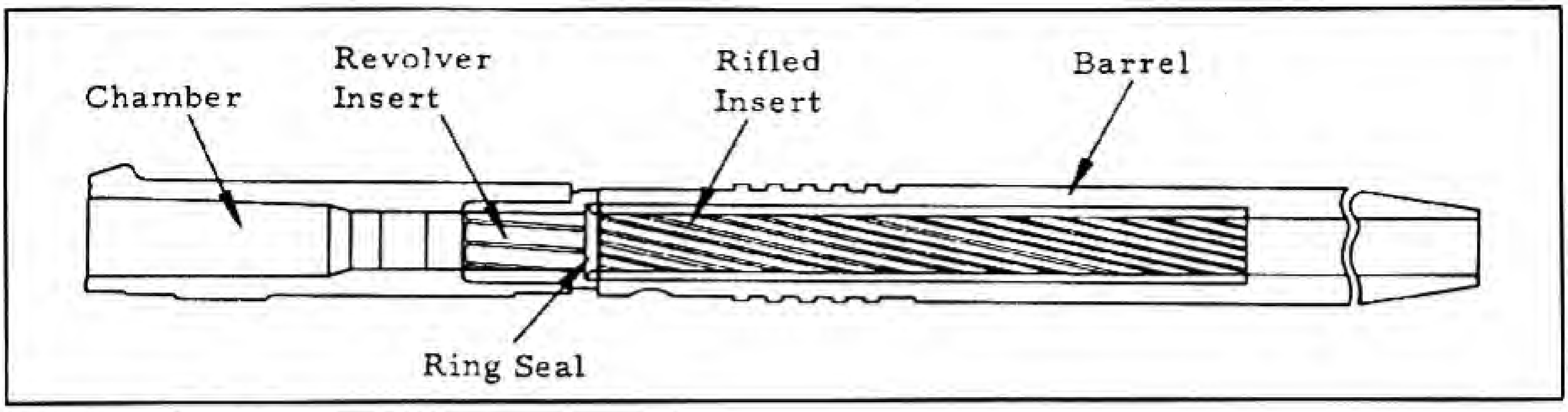
Power Requirements. The GAU-9 gun is self-powered and does not require any cycling power from the aircraft. A pneumatic system, mounted on the gun pallet, supplies the energy needed to air charge and clear the gun. Control voltage, 28 vdc-7.0 amperes maximum, is used to operate the system's solenoid valves. The charge and clear valves operate momentarily during those operations. The magazine drive valve is operated only during firing.

The control box is supplied with 110 vac-3.2 amperes voltage which is converted to 220 vac for the ammunition electric primers.

Modification to Meet U.S. Requirements

General. In the contractor's developmental testing of the GAU-9 system many parts of the 304Rk gun were found to have inadequate life. Although this program did not fund gun development directly, the contractor was able to fabricate a few new components from American materials and introduce them to the test program. The effect was remarkable in terms of improved parts life for the affected parts. Further, in several cases a reduction in production cost was achieved. Several of these efforts are described as follows.

Front Cover. This part represents a fine example of Oerlikon/contractor cooperation in the improvement of details. Both the contractor and Oerlikon have established that the original design of the 304Rk front cover was too flexible for firing unlubricated aluminum ammunition. An Oerlikon engineer had designed a new, stiffer cover, but this cover was to be completely machined from wrought material and the lead time in obtaining one for test was excessive. Starting from Oerlikon's improved design, contractor engineers slightly modified the cover so that it could be precision cast from maraging steel. Only a small amount of machining in the guide rails was needed to complete the part. The new cover is less expensive to produce and requires a much shorter lead time. The final version of this cover was used



Smoothbore Barrel System

throughout the entire Eglin test program. Previously, the original cover cracked and required weld repair in as little as 250 rounds.

Firing Pins. The original firing pins were subject to bending during the contractor test program. The contractor made new parts from a high stiffness material.

Gas Pistons. Gas pistons, originally made from a nitrided steel, cracked in as few as 250 rounds. After being manufactured to the same geometry but from maraging steel, the pistons have performed flawlessly. None of the new type pistons required replacement.

Other Problem Areas. Other parts problem areas have been identified in the testing program. Several of these are described below together with steps proposed for this solution.

Barrels. It was obvious from those delivered that improvement was highly in order. Under the schedules employed, most barrels failed in less than 1000 rounds.

The data presented was for the barrels fired at the contractor facility. Since the contractor tests were conducted primarily for component and subsystem checkout, no consistent burst schedule was adhered to throughout much of the test program. Also, at the contractor facility, the criteria for barrel failure was based solely upon erosion and not projectile stability because much of the development testing was done without targets. This definition of failure does not include causes such as gas port erosion.

Erosion at the breech end of the barrel was the principal cause of barrel failure. The contractor believed that this problem could be overcome through the use of replaceable rifled barrel inserts fabricated from an erosion-resistant material such as CG-27. This material had been tested at the contractor facility as a barrel insert for the Mk XI, 4200 round-per-minute, 20mm gun. Erosion resistance of CG-27 has been demonstrated to be as much as 20 times that of conventional barrel materials. The CG-27 insert was 20 inches long with a constant 12° right-hand twist spinning the projectile to 100,000 rpm. The remaining portion of the barrel is smooth bore and chrome-plated. An initial 3° spin-up was incorporated into the revolver's projectile support lands to reduce the angular acceleration in the barrel insert.

Operating Slide. The slide was another example of attempting to utilize a relatively soft material by nitriding. Cracking under gun loads and temperature is the inevitable result. To support the test program, the contractor had tooling fabricated and sliders precision cast from 250 grade, double vacuum melt maraging steel. The casting was sufficiently accurate so that the entire cam surface could be used as cast. Three of these castings were test fired with excellent results. The slider was silver-plated to prevent galling.

Receiver. The receiver on the 304Rk gun was prone to cracking at the point where the gas bracket attaches to the receiver. In the KCA-type GAU-9 gun this entire area was redesigned to provide a more tolerant load path through larger members.

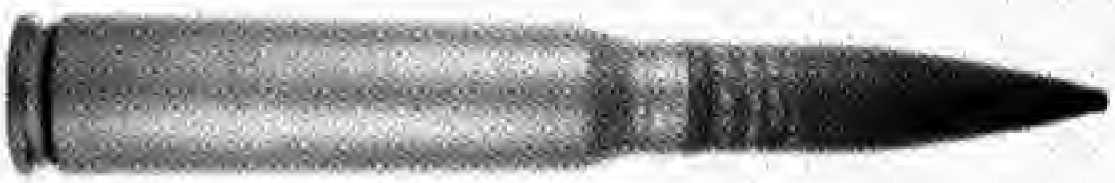
Test Results

General. Testing of the GAU-9/A gun system was conducted using dual guns. There were four guns originally delivered to Eglin AFB. Two were intended to be spares or used for parts as needed. Due to parts failures during the test, the two spare guns were dismantled for parts and lost their individual identities.

GAU-9/A Firing Tests Summary

Test Sequence No.	Rounds Fired			No. of Barrels Used	Average Barrel Life (rounds)	Remarks
	Left Gun	Right Gun	Total			
Checkout	173	172	345	---	---	
1	1,176	1,225	2,401	4	687	Includes checkout
2	1,083	1,037	2,120	4	530	
3	1,055	864	1,919	4	480	
4	6,212	6,328	12,540	16	817	Two barrels were ruined by seal failure. Average is for 14 barrels.
5	216	223	439	4	100	Rounds began keyholing near the end of 100-round bursts.
Total	9,915	9,849	19,764	32		
NOTE: Maximum rounds on any barrel was 1,113 during test sequence no. 4.						

Performance Summary. Rounds to be fired for a given test sequence were limited by barrel life after it became apparent barrel life was so short. Test sequences one, two, and three were progressively more severe on the barrels. Therefore, a less severe schedule was devised and designated test sequence number four. Barrel life dropped from 687 rounds per barrel in test sequence number one to 480 rounds per barrel in test sequence number three. The barrel life increased to 817 rounds per barrel while firing test sequence number four. Barrel life in test sequence number five was about 100 rounds. During a 100-round burst, the rounds start keyholing near the end of the burst indicating that the barrel failed.



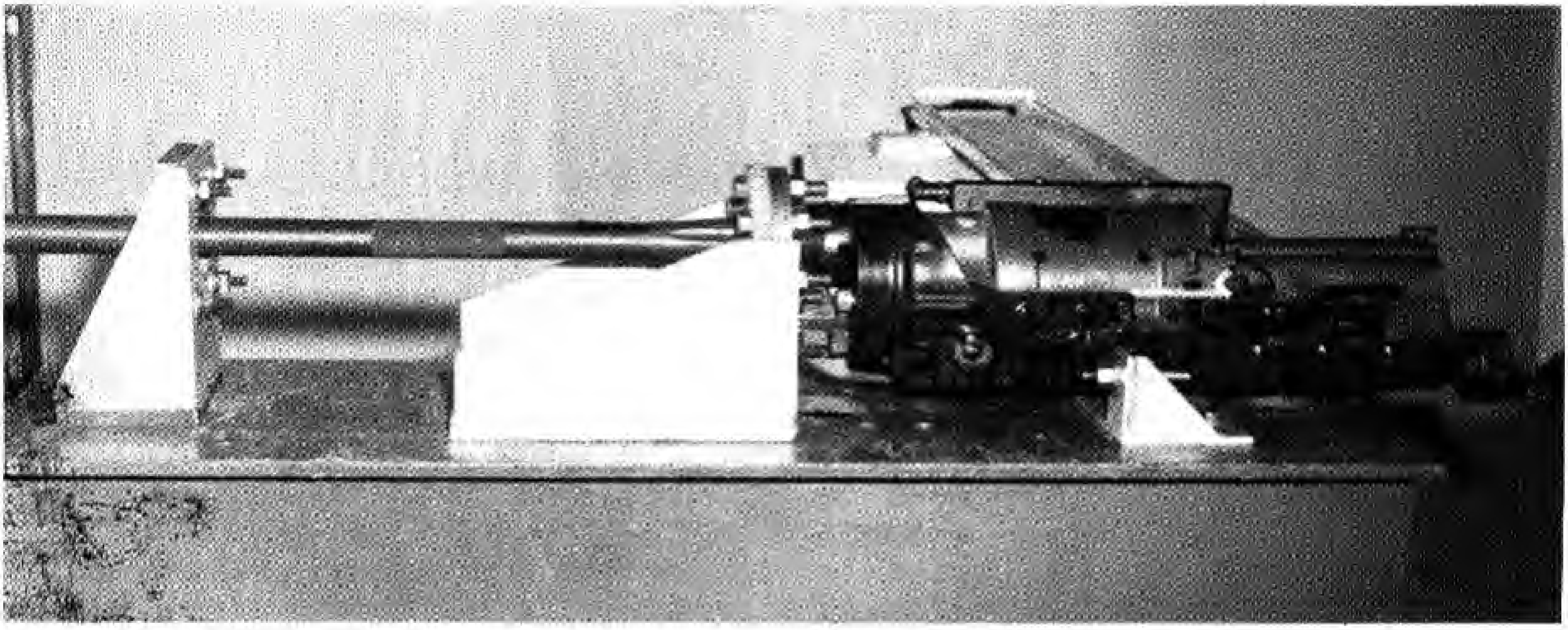
30mm GAU-9/A Ammunition (Photo courtesy of Woodin Laboratories.)

Ammunition

The GAU-9 gun system fires aluminum cased Oerlikon ammunition. Aluminum cased ammunition is completely practical for weapons in the 30-AX class. Aluminum cases can be routinely fired without resort to any field-applied lubrication.

Chapter 54

30mm DEFA 553 AIRCRAFT CANNON
FRANCE



30mm DEFA 553

History

The DEFA 553 30mm automatic cannon is the most refined version of the 500 series revolver guns that have been in continuous development since the end of WWII when the Germans first applied the revolver principle to aircraft cannons. The chief designer of the DEFA guns was Anton Politzer who was formerly a member of the Mauser design group which was responsible for the highly successful MG213C.

This late model DEFA cannon was installed in eleven types of tactical fighter aircraft. More than 11,000 of these weapons have been put in service in fifteen countries.

Description and Purpose

The 30mm DEFA Type 553 automatic cannon is a gas-operated, air cooled, single barrel, five chamber revolver type aircraft gun. The rate of fire is from 1100 to 1500 rounds per minute. The barrel is of the quick change fixed headspace variety with parabolic rifling. The gun mechanism is mounted in a cradle which is attached to the sprocket type feed mechanism. The linked ammunition can be fed from either side of the weapon. The weapon includes a pyrotechnic raming device.

The 553 has an overall length of 77 inches, 9.9 inches high, 11.5 inches wide, and weighs 176 pounds. The barrel is 59.7 inches long including muzzle device and weighs 32.7 pounds. The control system includes settings for 0.5 seconds, 1.0 second, and unlimited bursts. The normal complement of ammunition used in an aircraft systems is 180 rounds.

The DEFA 553 gun is designed for both internal and external mounting in aircraft. Four ammunition types are manufactured: target practice, air to air, air to ground, and armor piercing (shaped charge). The muzzle velocity is approximately 2700 feet per second.

Characteristics

Calibre	30mm
Muzzle Velocity	2,673 fps
Weight of Projectile	0.52 or 0.53 lbs.
Firing Rate	1100 to 1500 rpm
Weight of Complete Gun (with pyrotechnic recocking device)	176 lbs.
Barrel Weight	26 lbs.
Length of the Complete Gun (with hand recocking)	77 in.
Length of Barrel	55 inches
Number and Direction of the Rifling	16 toward right
Rifling End Orientation	7°
Recoil Strength	5,730 lbs.
Maximum Recoil Displacement	0.72 inches
DC Power Required	24 - 28 volts D.C.

Cycle of Operation

The five chambers of the revolver drum rotate successively behind and in line with the barrel. The ammunition feed and drum rotation are powered by a gas operated control slide. When a chambered round is in alignment with the barrel, the control slide is in the rest position, and all safety contacts are closed, only then can current be applied to the primer. The electrical monitoring devices located on the gun and in the firing harness prevent firing when the barrel is not in position, is unlocked, the cartridge is not in firing position, or the control slide is rearward. As the slide moves against the recoil springs, the drum is rotated one-tenth of a turn (36°). The recoil adapters then move the slide forward, rotating the drum another tenth of a turn, which aligns the next chamber with the barrel, and thus one firing cycle (72° or one-fifth of one rotation) is completed.

Complete operation of the weapon from feeding to ejecting requires five consecutive actions for each round fired. Each action corresponds to one firing cycle (72°). The first action partially introduces the round into the chamber with the cartridge case retained by the front lips of the link. The second action fully rams the cartridge into the chamber and the cartridge is secured by the cartridge retainer. Since the round is fully chambered, the third action rotates the round one position (72°). The fourth action rotates the revolver drum one-fifth of a turn to the locked firing position and when the voltage is applied, the round is fired. The fifth action ejects the fired cartridge case.

The cannon is initially loaded by cycling the gun with a hand recocking device. This unit is inserted into the weapon at the rear of the cradle and incorporates a bevel gear right angle drive, clutch, and auto-lock device. After four successive cycling operations of the recocking device with a crankshaft, the first cartridge is brought into firing position.

The cannon also for aircraft use has a pyrotechnic recocking device, which is capable in flight of cycling the gun once when firing has stopped.

Test Results

Two U.S. tests on the DEFA Type 553 aircraft cannon were conducted. The first was by the U.S. Air Force at Eglin Air Force Base in December 1970 and January 1971 and was cancelled out to verify published firing characteristics of the gun. The other, done by the Naval Weapons Laboratory, Dahlgren in 1973, was designed to obtain information on the reliability, maintainability, and safety of the DEFA Type 553 cannon in order to compare it with the 30mm ADEN cannon for the possible replacement of the ADEN by the DEFA in the Harrier aircraft.

The NWL/D test report concluded that the testing of the ADEN and the DEFA was too limited to fully evaluate the guns but, since the testing had not revealed any significant differences between the weapons systems, replacement of the ADEN by the DEFA was not recommended at that time.

Summary of Results of NWL/D Test

The 30mm DEFA 553 cannon has excellent performance characteristics as shown by the high reliability of 1354 mean rounds between stoppages (MRBS). Since the pyrotechnic recocking device would have cleared the only stoppage, which was caused by a faulty primer, the overall system reliability would increase to 2030 MRBS. In addition, eliminating the stoppage due to personnel error increass the reliability to 4061 MRBS.

The DEFA cannon was found to have the following design characteristics and safety features:

a. Barrel changes are easily made from the front of the weapon.

b. The cannon is simple to maintain. Tools are supplied for field maintenance of the gun and the electrical test equipment for testing the gun circuitry

30mm DEFA 552 553 Aircraft Cannon and Ammunition

is simple to operate.

c. Belted ammunition for the cannon does not have to correspond to the direction of feed, i.e., a right hand feed weapon will accept either right-hand or left-hand belted ammunition.

d. The DEFA 553 incorporates safety features which prevent firing when components are not completely locked in the firing position, and an anti-double feed device prevents feeding a round into a chambered round which has failed to extract.

Based on the barrel life criteria established by the British for the Type 552 cannon, the Type 553 cannon barrel had useful service life remaining after firing 3029 rounds. The small drop of 15 fps from new gun initial projectile velocity experienced during these tests did not adversely affect accuracy and indicates that the barrel life is greater than 2500 rounds.

The DEFA 553 cannon has one major safety hazard; a live round is positioned in line with the barrel and firing pin prior to initiating and upon termination of firing when a full round complement has not been fired. To compound the "loaded gun" situation, the possibility exists that the DEFA ammunition primer is susceptible to firing in an electromagnetic radiation environment.

A performance assessment for the DEFA 553 and the Aden 30mm cannons indicates that the DEFA is approximately twice as reliable as the Aden gun (based on overall weapons stoppage rates) and is the more accurate of the two weapons. However, the two Aden stoppages were due to primer failures and of the three DEFA stoppages, one was a primer failure, one was directly attributable to the weapon and one stoppage was due to ancillary equipment.

Barrel life, based on technical information provided at the time of weapon evaluation, indicates the Aden barrel to be twice as serviceable as the DEFA. However, DEFA representatives stated that the 553 cannon barrel life has been upgraded to 5000 rounds, thus making it comparable to the Aden.

The Aden and DEFA 553 cannons are similar in appearance and operation. A noticeable difference in operation is the DEFA's requirements of four cocking actions to fully load, whereas the Aden requires only three. In addition, the DEFA is equipped with a pyrotechnic recocking safety feature for one automatic in-flight recharging. This device is essentially intended to be operated in flight to remedy a firing stoppage.

The Air Force test results showed that the published data on the DEFA Type 553 cannon was substantially correct.

When evaluated in terms of probability of hitting the target, destruct capability, ease of installation and relative weight factors, these important elements of aircraft gun systems favor the 30mm DEFA when considering gun armament for a fighter aircraft.

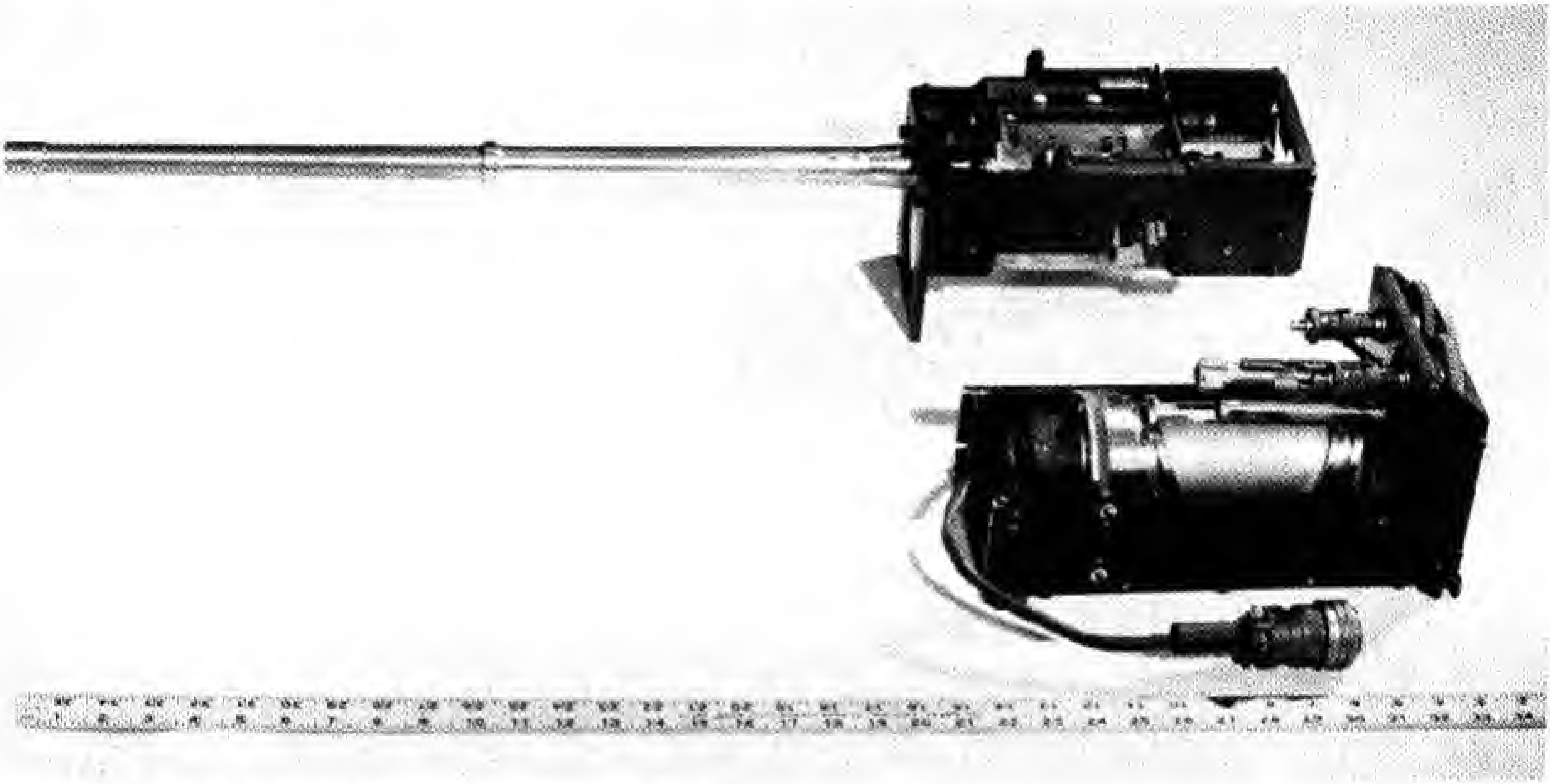
AUSTRALIA	INDIA	PAKISTAN
BELGIUM	ISRAEL	PERU
BRAZIL	ITALY	SOUTH AFRICA
FRANCE	LEBANON	SPAIN
GERMANY	LIBYA	SWITZERLAND

DEFA 30mm Cannon used in 15 countries

Chapter 55

7.62mm EXTERNALLY POWERED ARMOURED VEHICLE MACHINE GUN (Prototype)

HUGHES TOOL COMPANY (Presently McDonnell Douglas)



7.62mm Externally Powered Armored Machine Gun (EPAM)

History

The weapon was designed, built and tested during the period between September 17, 1970 and May 30, 1972. The work was done under contract for the U.S. Army weapons command.

One firing fixture was built and tested.

The prototype was fabricated and designed simply. The receiver, motor housing and gearbox were all assembled from aluminum and steel plates bolted together. No attempt was made to reduce the weight or bulk of the structure. It is anticipated that any future receiver made for the gun using more standard gun fabrication techniques would result in significant weight and bulk savings, plus the elimination of all screws from the assembly.

In spite of this construction method, the weight of the prototype is only 1.5 pounds more than an M73.

Description and Purpose

The design goals specified for this weapon were, a single barrel, externally powered armored vehicle machine gun with approximately the same dimensions as the M73 machine gun. High reliability and provision for a dual feed were also required.

The completed test fixture was similar in size to the M73 machine gun. It featured a constant velocity dual sprocket feed, open bolt operation, and electric drive. The gun used standard 7.62mm ammunition and the conventional link.

Cycle of Operation

The weapon was operated by a 24 volt dc electric motor which features a reverse rotation, dynamic electrical braking and an integral spring applied disc brake. The reverse rotation of the motor provides the dual feed selection capability. The mechanical/dynamic braking of the motor provides the equivalent of open-bolt operation by stopping the bolt only at the fully open position.

Integral with the motor is a two-stage, nine-to-one planetary gearbox that reduces the motor speed to the 1200 rpm required for operation.

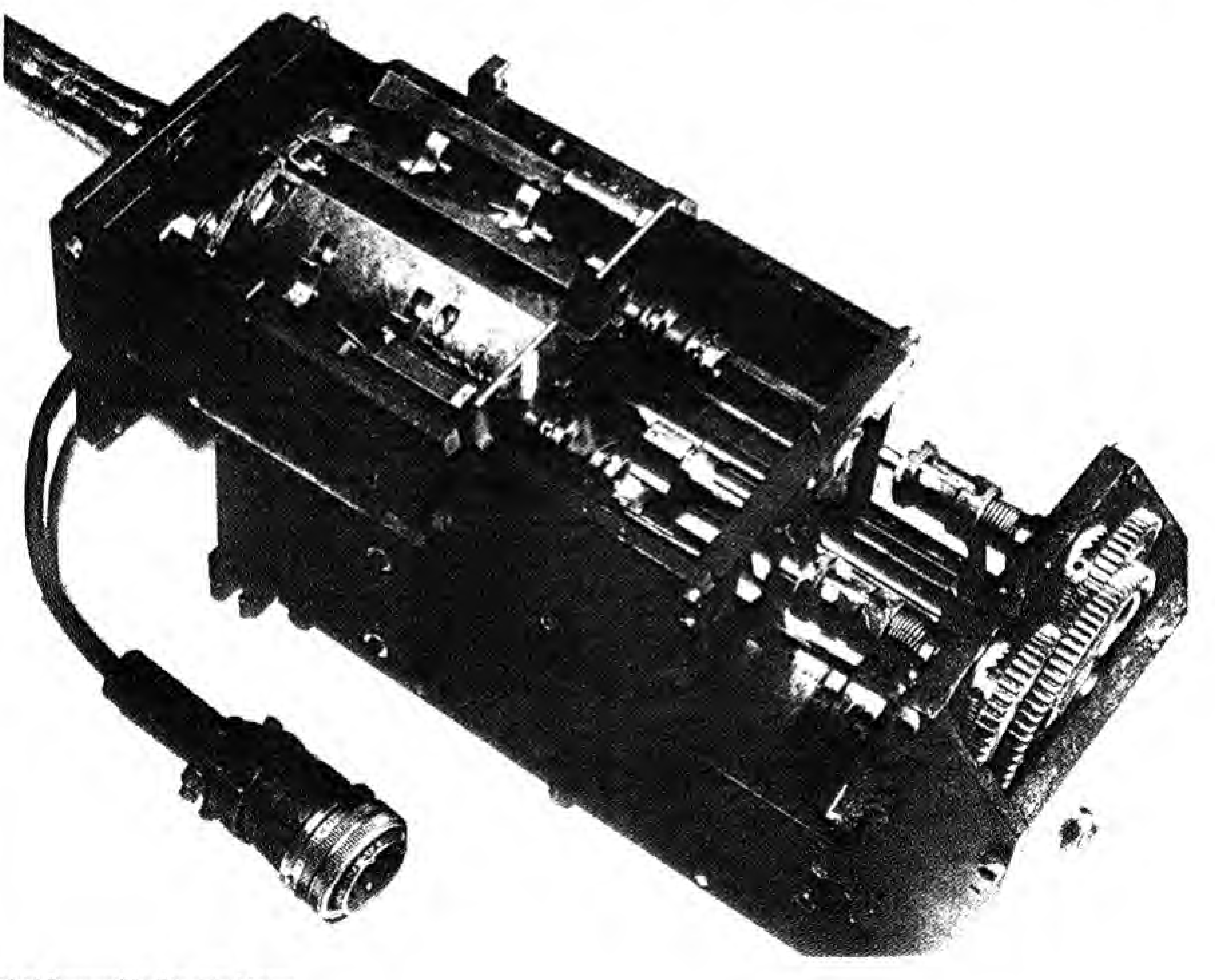
The bolt drive cam surrounds the motor and is coupled by a sliding key to the output shaft of the gearbox. The cam revolves twice for each cycle of the bolt. The cam itself has constant acceleration characteristics and maximum slopes of 41 degrees.

The cam and motor assembly is located directly below the bolt assembly and cycles the bolt by means of twin roller cam followers on the bolt carrier.

The bolt assembly is comprised of six main components, the bolt head for locking, the extractor, the firing pin, the bolt carrier, the guide rails, and the cam followers.

The bolt head is a three locking lug design and the upper locking lug also acts as the rammer during the chambering of the round.

The bolt is locked by the action of a cam pin in the bolt head acting on a cam slot in the bolt carrier. This locking action also serves to unsear the firing pin,



EPAM Reversible Electric Motor

which has been preloaded by the forward movement of the bolt carrier against a pivoting stop on the receiver.

The bolt is located for its fore and aft motion by two half-inch diameter rods that ride in semicircular guideways in the receiver.

In the bottom of the bolt carrier is the drive cam follower that uses a pivoted shoe which acts on the cam only at the crossover point where it is positively guided to prevent misalignment of the rollers at the intersecting cam path.

The left-hand track also serves the dual purpose of providing an ejection port for spent cases.

The spent case or unfired round is extracted from the chamber by a semi-circular extractor located in the bolt face. As the end of the case or the tip of unfired round clears the end of the barrel, it is pivoted down and to the left by a spring-loaded ejector pin so that the case is rotated down through the ejection port in the left hand bolt guideway. When the case is 90 degrees to the axis of the barrel, it is caught by a wedge in the port.

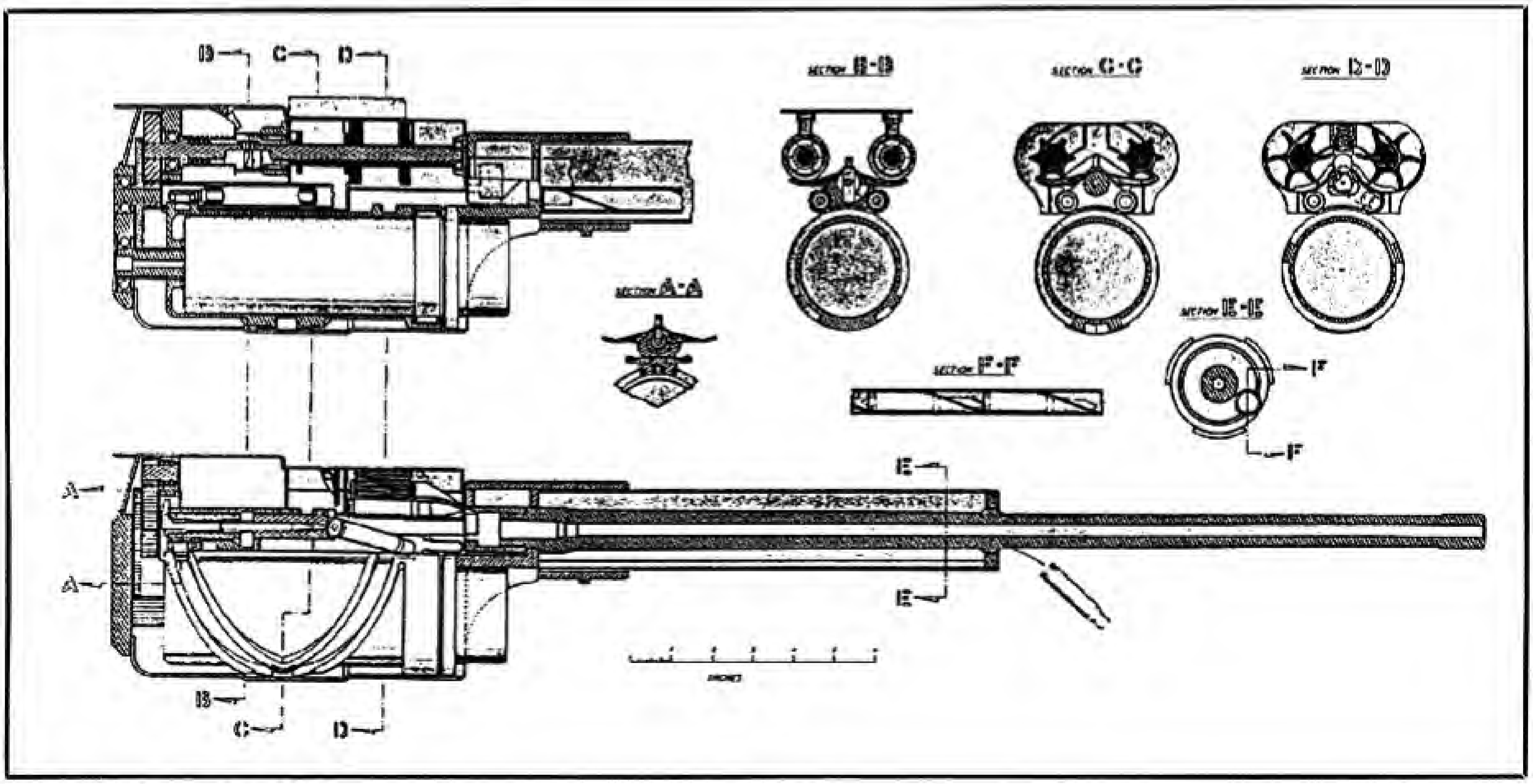
As the bolt moves forward, the left guide rod strikes the head of the case and rotates it down and out of the weapon.

The sprocket feeders are driven by a spur gear train that meshes with a pinion gear on the bolt cam drive shaft. This gear train reduces the output of the gear motor to 100 rpm for the feeder sprockets.

If the motor is turning counterclockwise, so are the sprocket drive gears. The ratchet in the right-hand sprocket shaft transmits no power to the sprocket, but the ratchet in the left-hand shaft now transmits power to feed the left-hand belt by driving the sprocket.

Characteristics

Bore Size	7.62mm
Muzzle Velocity	2700 fps
Rate of Fire	550 rpm
Basic System of Operation	Power Driven
Locking System	Rotating Bolt
Power Source Feed System	Power Driven
Feed System	Sprocket Type
Type of Feed (location)	Link
Method of Chambering	Ram
Manufacturer	Hughes
Utilization	Vehicle
Ammunition Type	7.62 x 1
Length	34.5 in.
Width	4.6 in.
Height	6.6 in.
Weight	29.5 lbs.
Type of Firing Mechanism (firing pin)	Percussion
Method of Cooling	Air

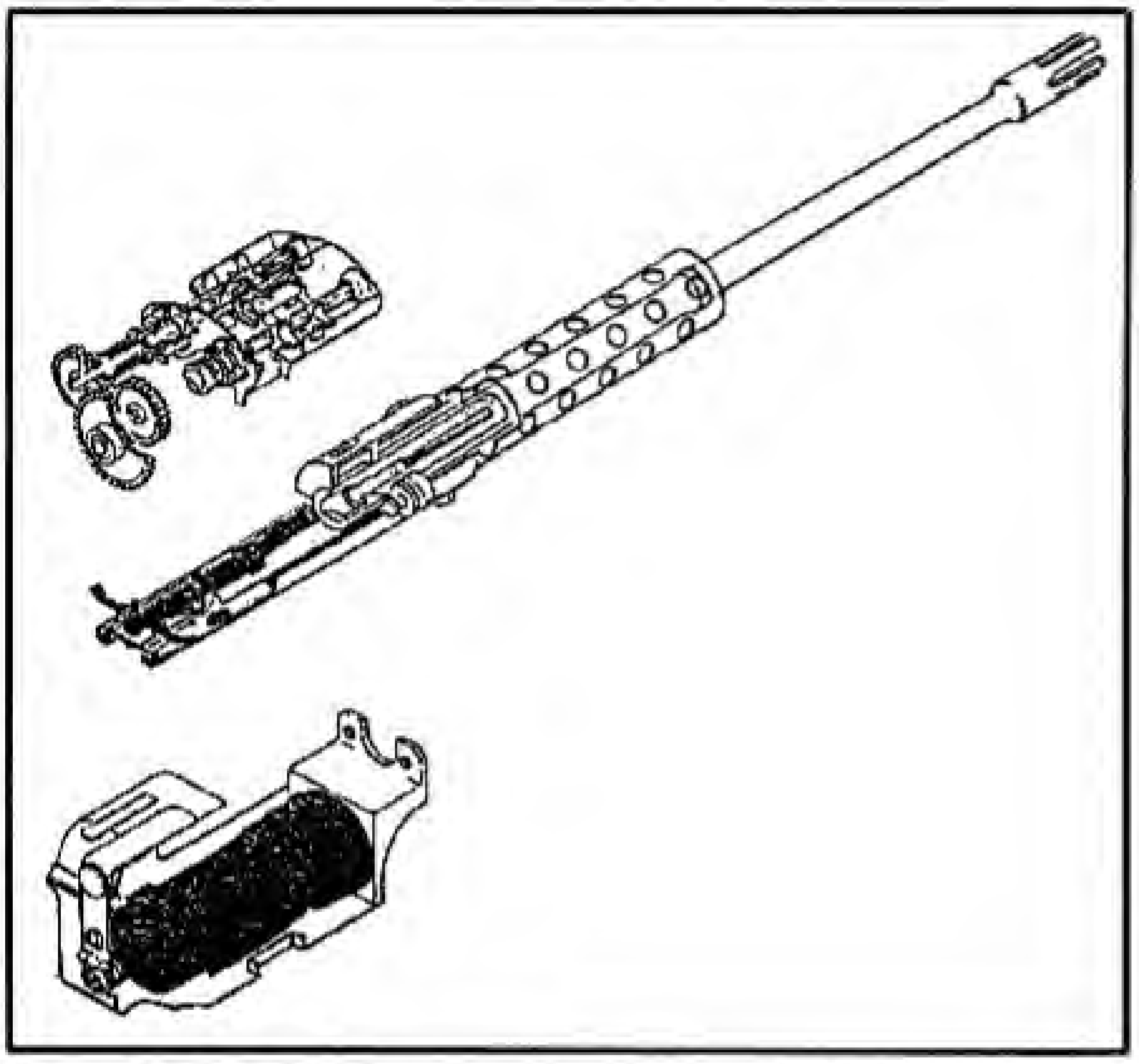


Exploded View of EPAM

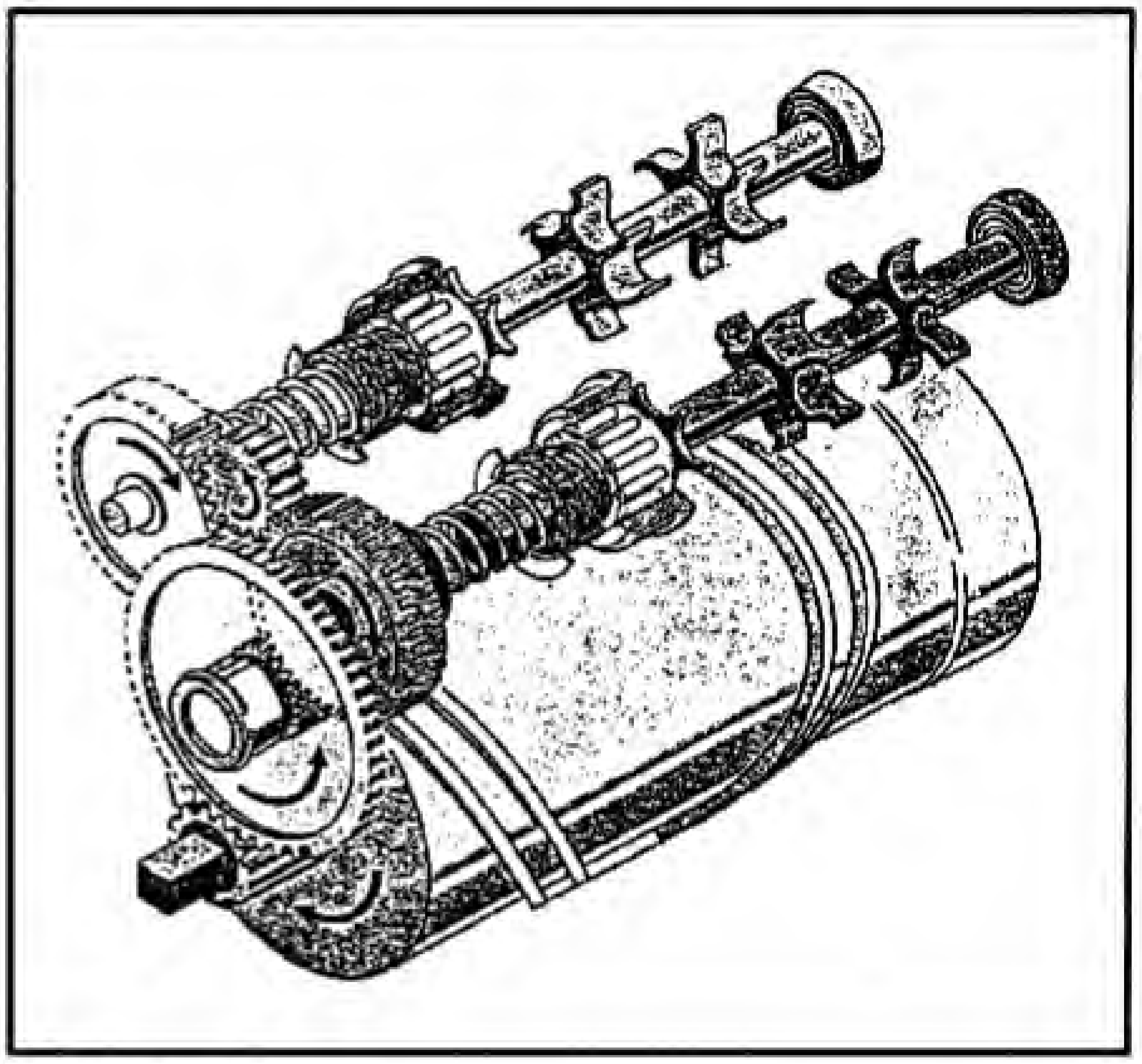
Each sprocket has six stations and each ratchet has six teeth, so that timing during change of feed is positive and automatic.

With the initiation of a burst of fire, the belt of ammunition is brought to rate by the drive motor. Once the gun is at rate which takes less than two cycles, the belt velocity remains constant with no acceleration or deceleration until the end of the burst. This means that the belt velocity is as low as possible and the loads on the links and other components of the feed system are a minimum. Available belt pull, because of the constant application of force, is at a maximum, limited only by link strength or stretch.

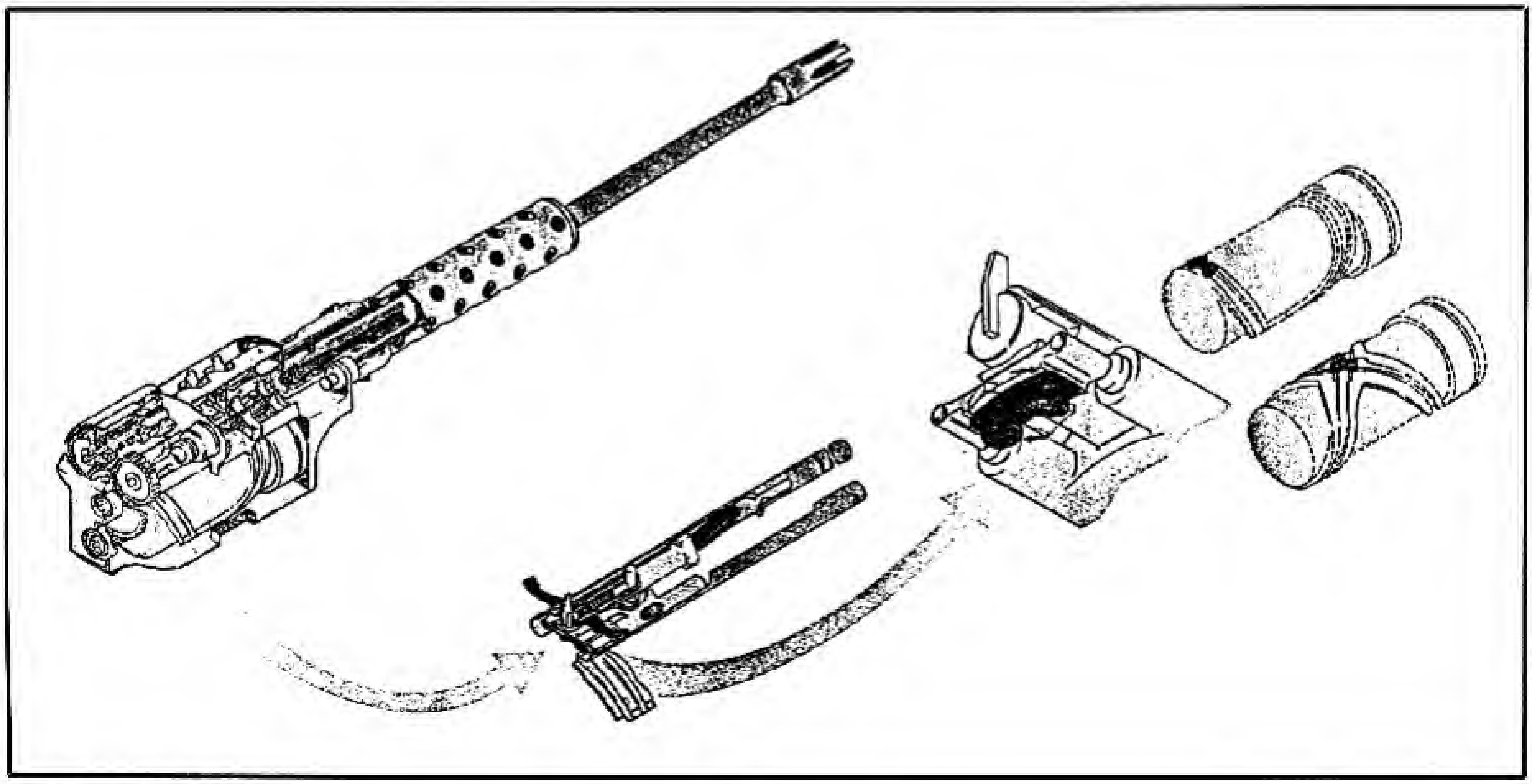
As the ammunition belt moves around the sprocket, a "long-horn" stripping rammer which is attached to



Principle Assemblies



EPAM Dual Feed



Bolt Drive Mechanism

the rear of the reciprocating bolt, contacts the base of the round and moves it forward out of the link. This is accomplished during sprocket rotation without interferring with the link. After stripping, the link falls away down a link chute.

During the next cycle of the gun, this prestripped round is cammed, by the sprocket, under a spring-loaded platten and onto the top of the bolt. As the bolt moves to the rear and from under the round, the round is forced down onto the feed lips and is ready to be fed by the bolt on the next cycle.

Test Results

All testing was done by Hughes and a total of 2,582 rounds were fired during the three phase testing program.

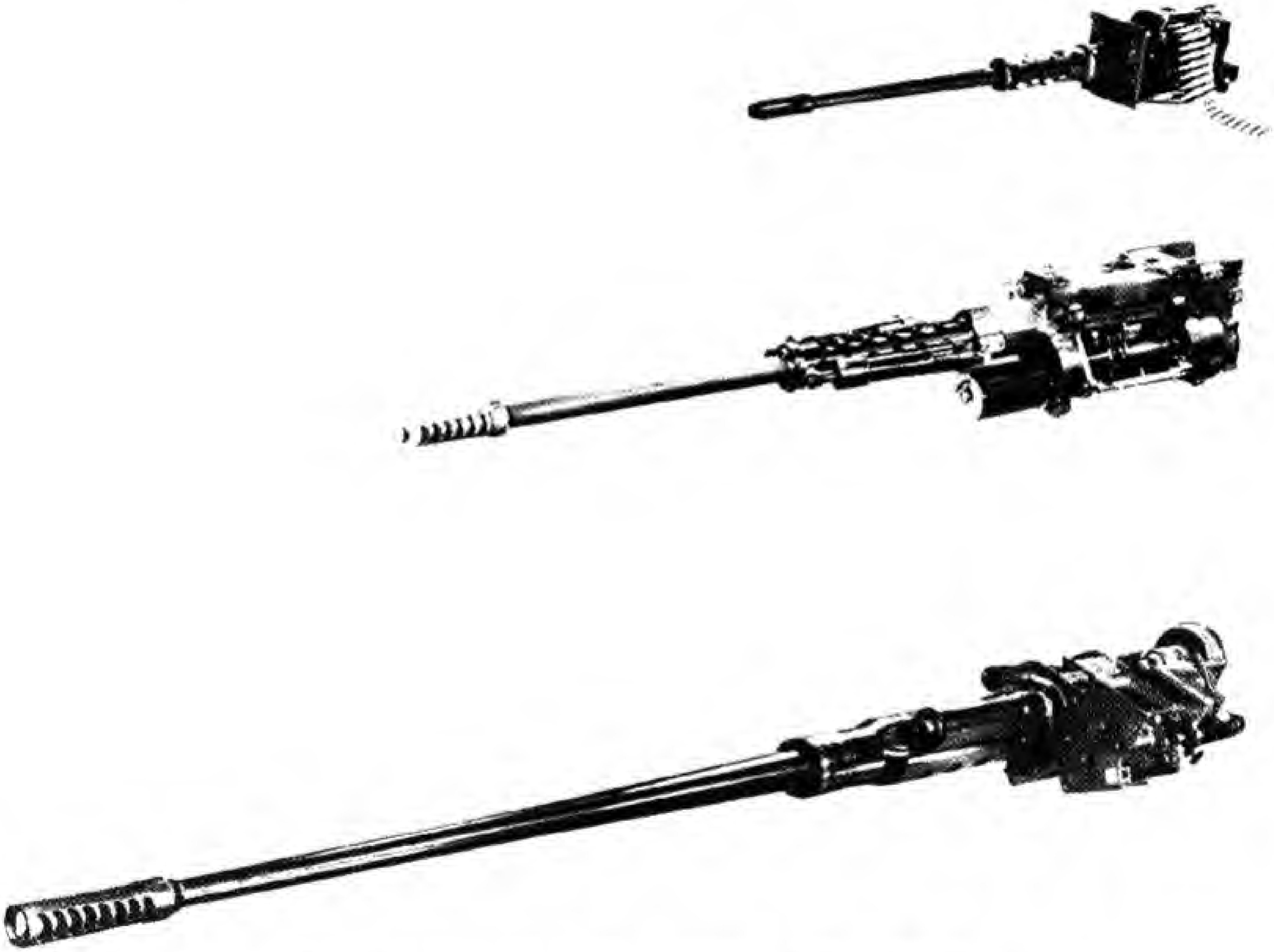
The first phase of testing consisted of proofing the system. During these firings, the firing pin was modified to eliminate pierced primers.

The second phase testing was with dummy ammunition to check the motorized operation of the weapon.

The final phase of testing revealed a number of ejection problems. After a number of modifications the gun functioned properly. The last 650 rounds were fired without any stoppages.

Chapter 56

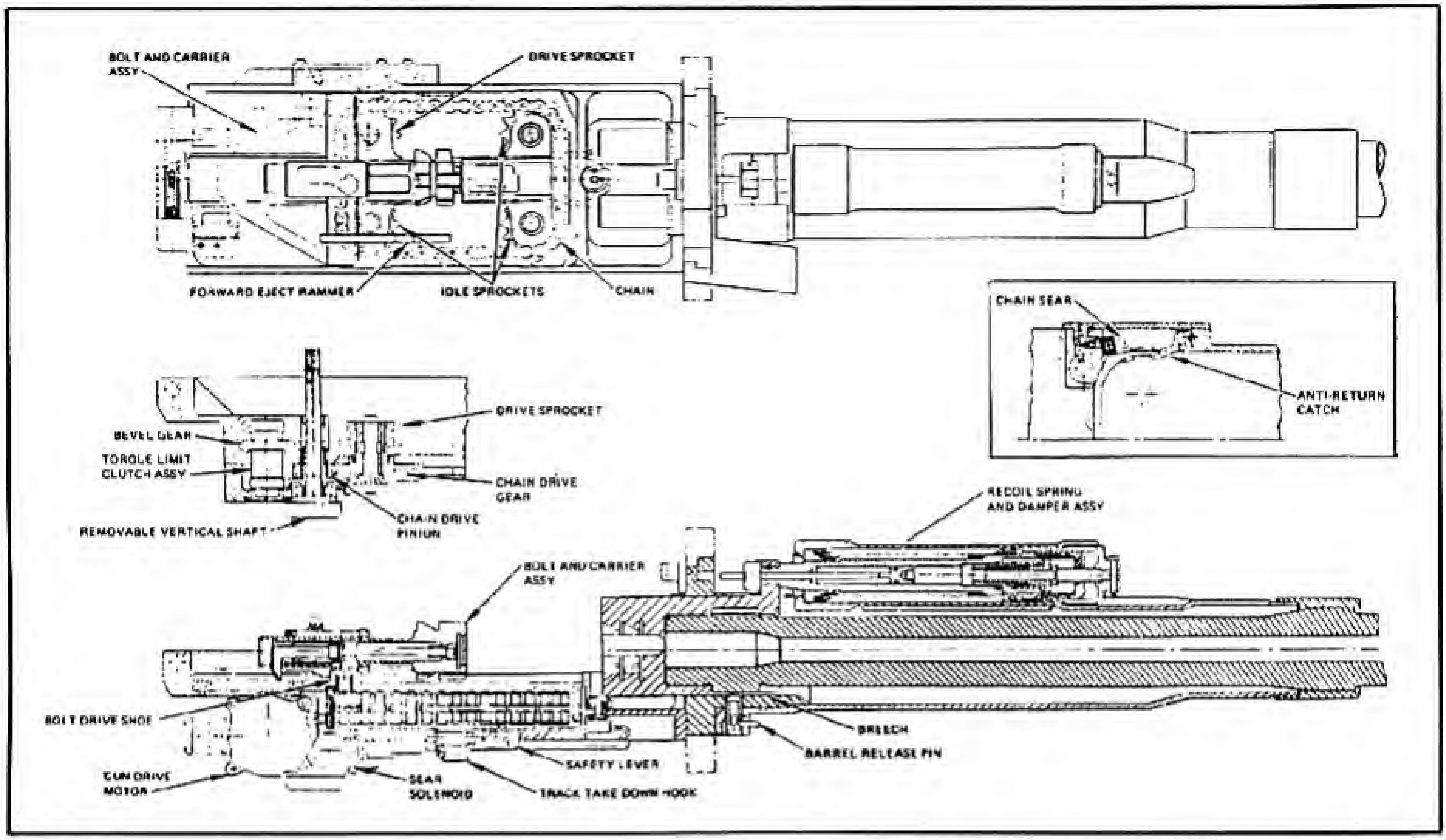
THE CHAIN GUNS
7.62mm EX-34, 30mm M230 and 25mm M242
HUGHES TOOL COMPANY (Presently McDonnell Douglas)



Chain Gun Family (from top to bottom): 7.62mm EX-34, 30mm M230, and 25mm M242

History

The Chain Gun in calibre WECOM 30mm fired its first round in April 1973, four months after initiation of the program. In July, the U.S. Army Armament Command sponsored a 2500-round feasibility firing test that was successfully completed with the prototype (A Model) gun on 13 September 1973. During the summer of 1974, the second generation (B Model) Chain Gun underwent tests in accordance with the Hughes program schedule for the Advanced


BOLT AND CARRIER ASSY
DRIVE SPROCKET
FORWARD EJECT RAMMER
IDLE SPROCKETS
CHAIN
CHAIN SEAR
ANTI-RETURN CATCH
DRIVE SPROCKET
BEVEL GEAR
TORQUE LIMIT CLUTCH ASSY
CHAIN DRIVE GEAR
CHAIN DRIVE PINION
REMOVABLE VERTICAL SHAFT
RECOIL SPRING AND DAMPER ASSY
BOLT AND CARRIER ASSY
BOLT DRIVE SHOE
BREECH
BARREL RELEASE PIN
SAFETY LEVER
GUN DRIVE MOTOR
SEAR SOLENOID
TRACK TAKE DOWN HOOK

XM242 Assembly Drawing

Attack Helicopter YAH-64.

By January 1975, two model "B" guns had been built and one model "C" (A linkless feed version for the YAH-64). Over 50,000 rounds were fired.

The three weapons comprising the present Chain Gun family are the 30mm M230E1 for Attack Helicopter application, the 25mm M242 dual feed automatic cannon for primary fighting vehicle armament and the 7.62mm machine gun for coaxial installation and a variety of other armor requirements.

Each Chain Gun weapon fires both foreign and U.S. ammunition interchangeably ensuring logistic commonality with NATO forces.

General Description

All Chain Gun weapons regardless of calibre, are single barrel externally-powered guns which incorporate a rotating bolt mechanism driven by simple, reliable chain drive. Bolt action is such that the gun will handle brass, steel or aluminum-cased ammunition with equal facility.

Since all moving parts are totally keyed together, each and every motion within the gun is precisely timed and fully controlled. Further, 100 percent positive round control within the Chain Gun weapons' system eliminates those malfunctions due to conventional ammunition problems. These factors, coupled with the smooth power flow from an electric drive motor, ensure high reliability at all rates-of-fire.

The chain drive concept permits a simplified gun cycle which operates safely from an open bolt without requirements for chargers, declutching feeders, or other special devices. Because of its simplicity, the production cost of these guns is well below that of contemporary weapons.

To date nearly one million rounds have been fired in the three calibres of Chain Gun weapons now in development. All firing tests positively demonstrate the superior reliability, performance and potential for battlefield effectiveness necessary for all future combat requirements.

30mm M230 Area Weapon

The M230E1 was developed to meet the U.S. Army's urgent requirement for a lightweight, highly reliable attack helicopter area weapon. Already specified for the Hughes YAH-64 Advanced Attack Helicopter, the M230E1 was under review for early integration with the Universal Turret System on the AH-1S Cobra Helicopter.

The M230E1 is a variation of the 30mm M230 which has been tried and proven through 250,000 rounds of firing by both Hughes Helicopters and the U.S. Army. The E1 model, however, has been rechambered to fire both ADEN/DEFA and U.S. built 30mm ammunition. Minimal changes have been made to the basic mechanism to accommodate the slightly longer and more powerful round of ammunition. Additionally, the basic M230E1 gun will fire either linked or linkless ammunition through the use of a lightweight interchangeable transfer unit. For present requirements, linked ammunition will be utilized in the AH-1S Cobra installation while the YAH-64 AAH will capitalize on a linkless conveyor system. The basic M230E1 gun, however, is interchangeable between the two attack helicopter systems.

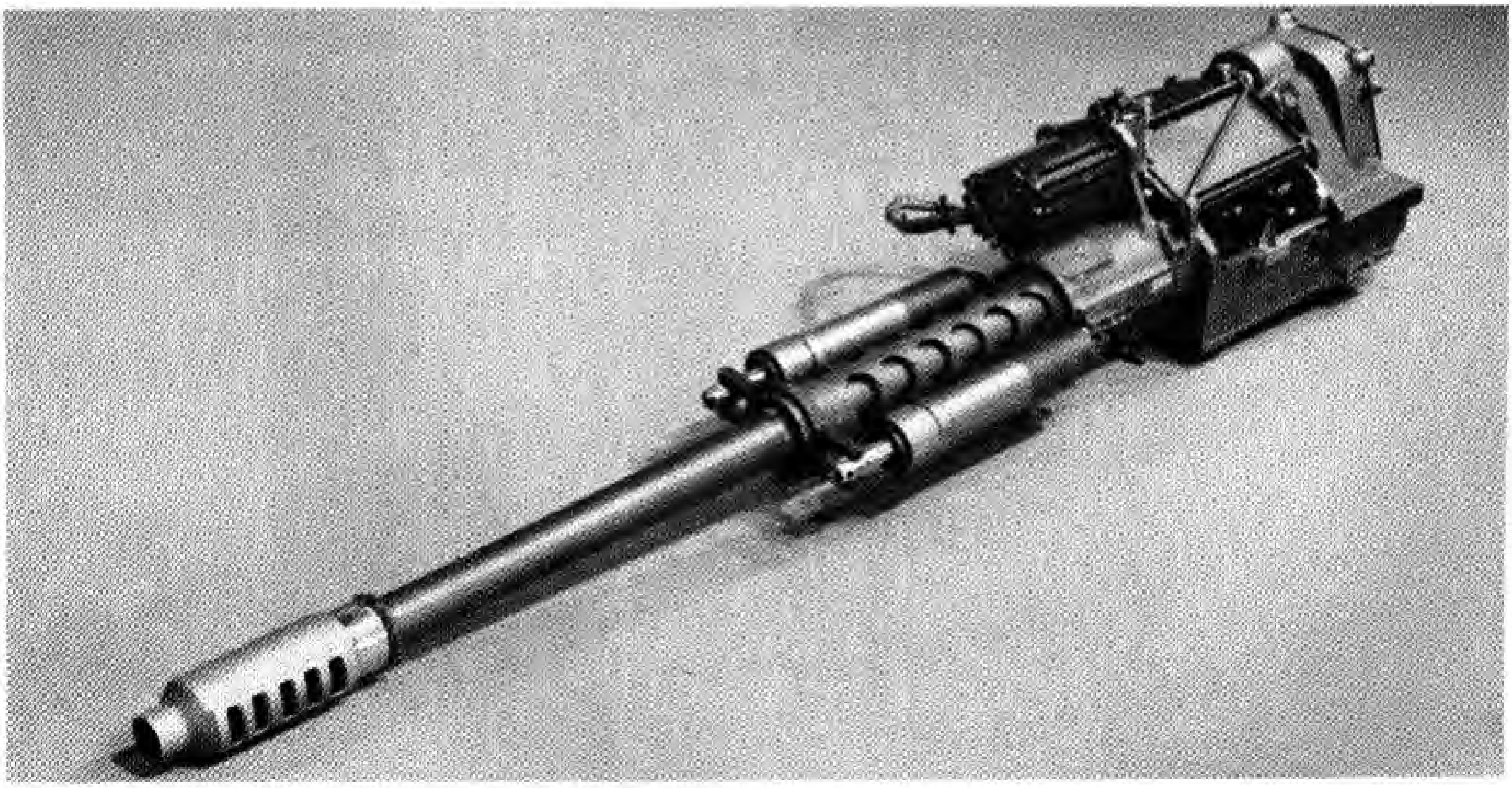
The Hughes Company can proudly point out the following superior features:

The Hughes Chain Gun will fire the XM552/639 family of ammunition. All rounds are handled with care, either at constant velocity or with accelerations. To protect the 30mm fuse, fore and aft motion is limited by a rim guide throughout the cycle. Finally, no part of the gun, at any time (including the eject cycle), is allowed to touch the projectile fuse area.

Characteristics*

Calibre	30mm
Ammunition:	
Combat	ADEN/DEFA/XM789/XM799
Practice	XM788
Weight:	
Receiver	63 lb.
Barrel	35 lb.
Recoil Adapter	12 lb.
Linked or Linkless Transfer Unit	8 lb.
Total Gun System Weight	118 lb.
Dimensions:	
Length	64.5 in.
Width	10 in.
Height	11.5 in.
Barrel Life	to 20,000 rounds
Rate of Fire	750 rpm
Time to Rate	0.2 sec.
Time to Stop	0.1 sec.
Clearing Method	Open Bolt
Effective Impulse (with muzzle brake)	45 lb. sec.
Dispersion	1 mil (1)
Power Required	6.5 hp
Reliability Predicted	100,000 MRBF

*includes gun, barrel, drive motor, integral feeder and internal recoil mechanism.



30mm XM230E1 Chain Gun

25mm M242 Automatic Cannon

On 19 February 1979, the U.S. Army selected the 25mm M242 dual feed automatic cannon as the primary weapon for installation in the XM2 Infantry Fighting Vehicle and XM3 Cavalry Fighting Vehicle. During a nine-month competitive evaluation, the M242 firmly demonstrated its durability, reliability, accuracy and safe operation under all firing conditions.

For Fighting Vehicle installation, the entire gun—with integral dual feed, remote feed select and an internal recoil mechanism—weights 230 pounds and provides for semiautomatic and automatic fires of 100 and 200 rounds per minute. The M242 effectively fires both European and U.S. 25mm ammunition, ensuring interchangeability and logistic commonality on the modern battlefield. Fired cases are ejected forward (overboard) and long dwell after firing eliminates gun gas buildup in all turreted installations.

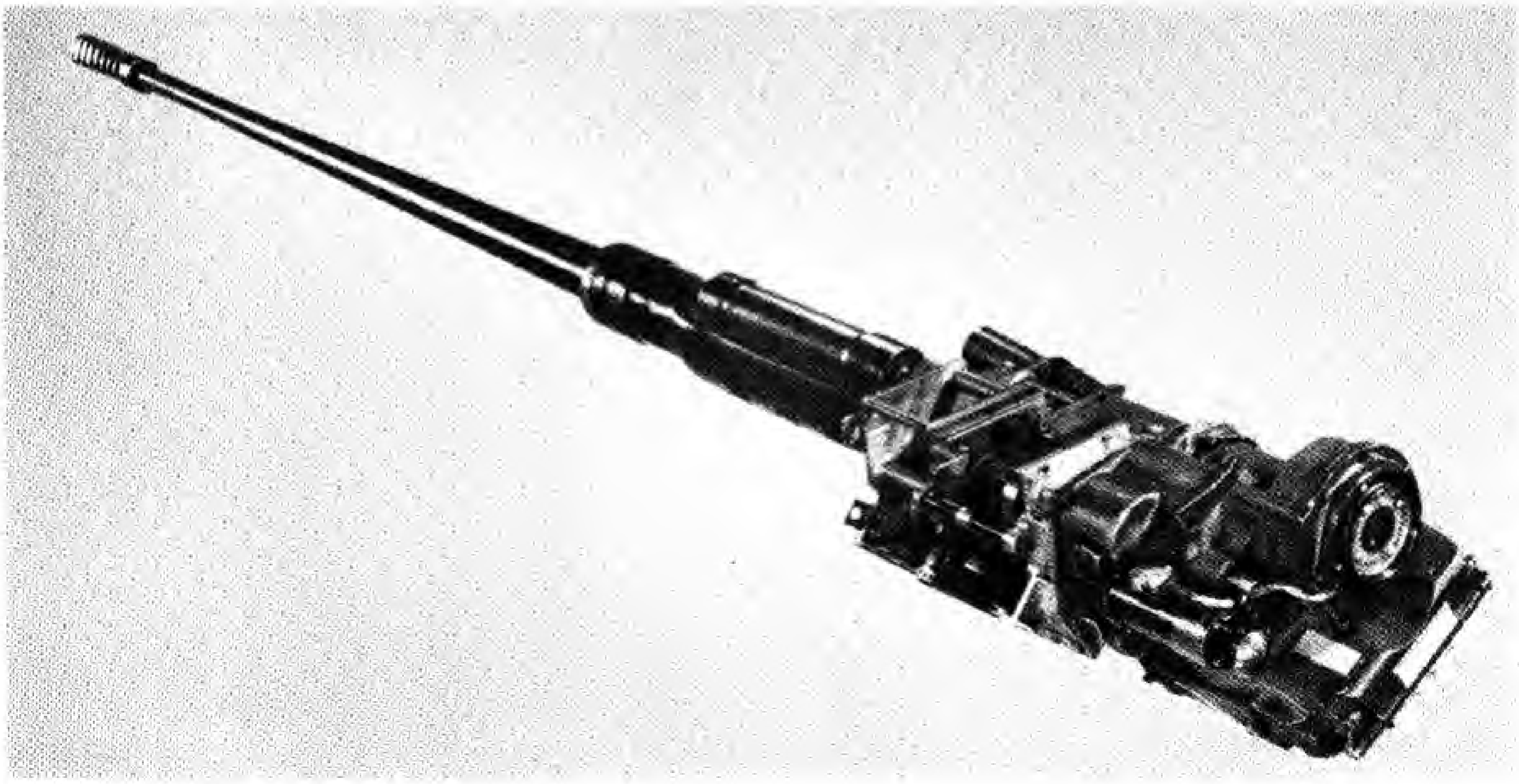
Hughes claimed the M242 offers a progressive step forward in force modernization, combining increased target servicing, improved survivability and high battlefield availability with reduced life cycle cost.

Characteristics*

Calibre	25mm Dual Feed
Ammunition	Oerlikon KBA/U.S. XM790 Series
Weight:	
Receiver Assembly	92 lb.
Barrel Assembly	89 lb.
Feeder Assembly	49 lb.
Total Gun System	230 lb.
Dimensions:	
Length Overall	108 in.
Width	12.7 in.
Height	14.7 in.
Length behind front of feed	21 in.
Barrel Length	80 in.
Barrel Life	13,000 rounds
Rate of Fire	Single Round, 100, 200 rpm**
Time to Rate	0.15 sec.
Time to Stop	0.12 sec.
Power Required	1.5 hp
Clearing Method	Open Bolt
Safety	Absolute Hangfire Protection
Case Ejection	Forward
Peak Recoil Force	7000 lb.
Dispersion	0.5 mil (1)
Reliability Predicted	25,000 MRBF

*includes gun, barrel, drive motor, integral feeder and internal recoil mechanism.

**475 rpm available with motor interchange.



25mm XM242 Chain Gun

Ammunition

The Hughes 25mm Chain Gun M242 fires the 25mm Oerlikon KBA/U.S. XM790 Series Ammunition.

25mm Oerlikon KBA/U.S. XM790 Series Ammunition. (Photo courtesy of Woodin Laboratories.)

7.62mm EX-34 Machine Gun

The 7.62mm automatic weapon is the smallest member of the Chain Gun family and has been developed specifically to meet an urgent need for a reliable and effective armor machine gun. For coaxial installation, the weapon is so configured to permit barrel change in less than ten seconds without downloading ammunition.

The 7.62mm machine gun incorporates the basic features of the proven 30mm and 25mm weapons and addresses the critical problems of gas, brass and feed normally associated with all enclosed gun installations. Like the M242, this weapon also ejects fired cases forward (overboard) and capitalizes on long dwell time to eliminate gas build-up in cupola or turreted installations.

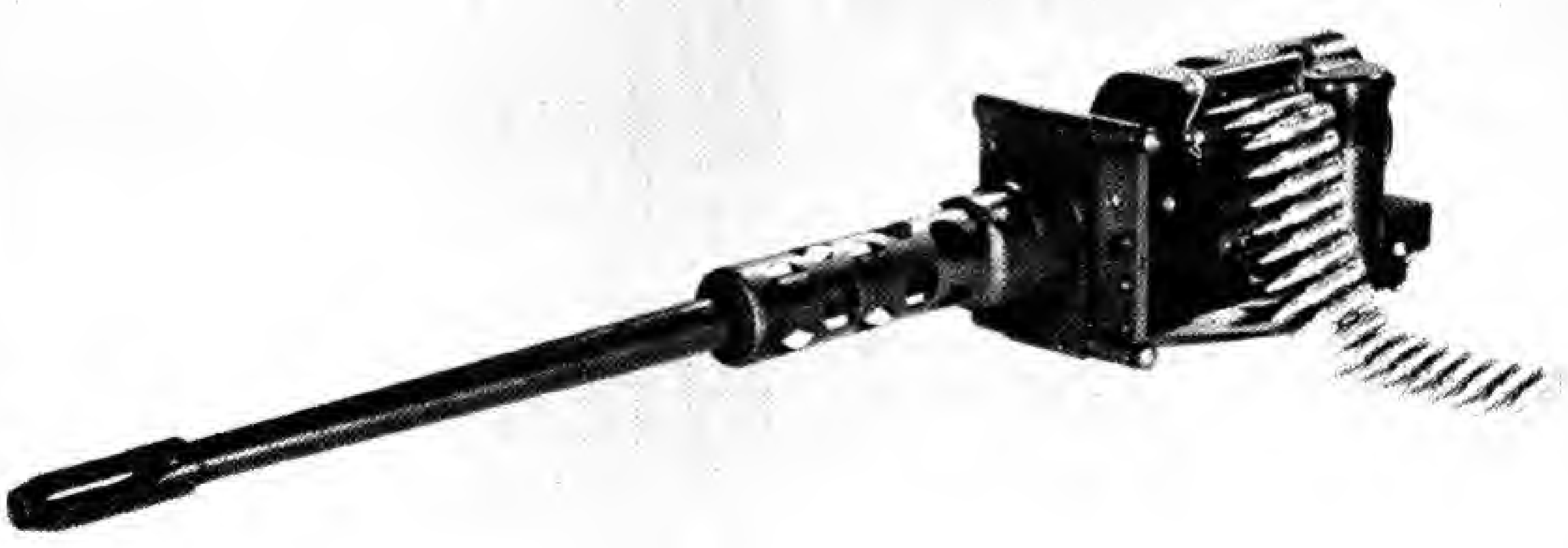
Compact and lightweight, the EX-34 machine gun is physically interchangeable with the coaxial weapon in M60 tanks and no mounting modification whatsoever is required to replace the presently installed M73 or M219 machine guns.

Over 400,000 rounds have been fired through 7.62mm Chain Gun weapons including two bursts of over 10,000 rounds each (20 minutes burst length at 500 rounds per minute). Under contract to the U.S. Army Armament Research and Development Command, Hughes Helicopter has delivered four prototype weapons for military potential testing and evaluation.

Characteristics*

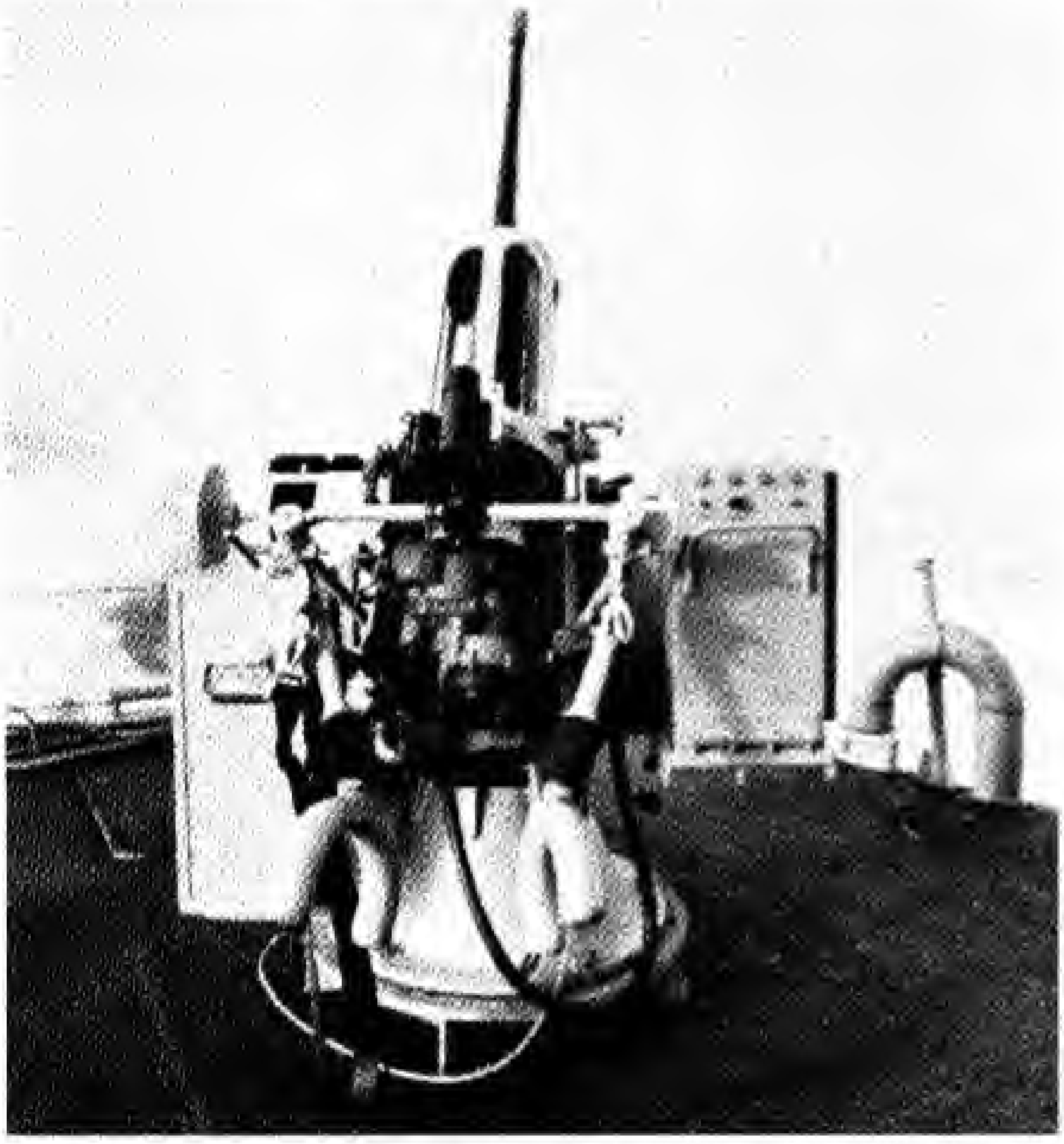
Ammunition	7.62mm NATO
Links	M 13
Weight	29 lb.
Length (with Flash Hider)	35 in.
Width	5.7 in.
Height	6.5 in.
Barrel Length	22 in.
Length Behind Rear Feed	4.5 in.
Rate of Fire	Single Shot to 600 rpm
Time to Rate	0.15 sec.
Power Required	1/3 hp
Reliability Predicted	50,000 MRBF
Clearing Method	Open Bolt
Misfire	Cycle Through

*includes gun, barrel, drive motor and feeder



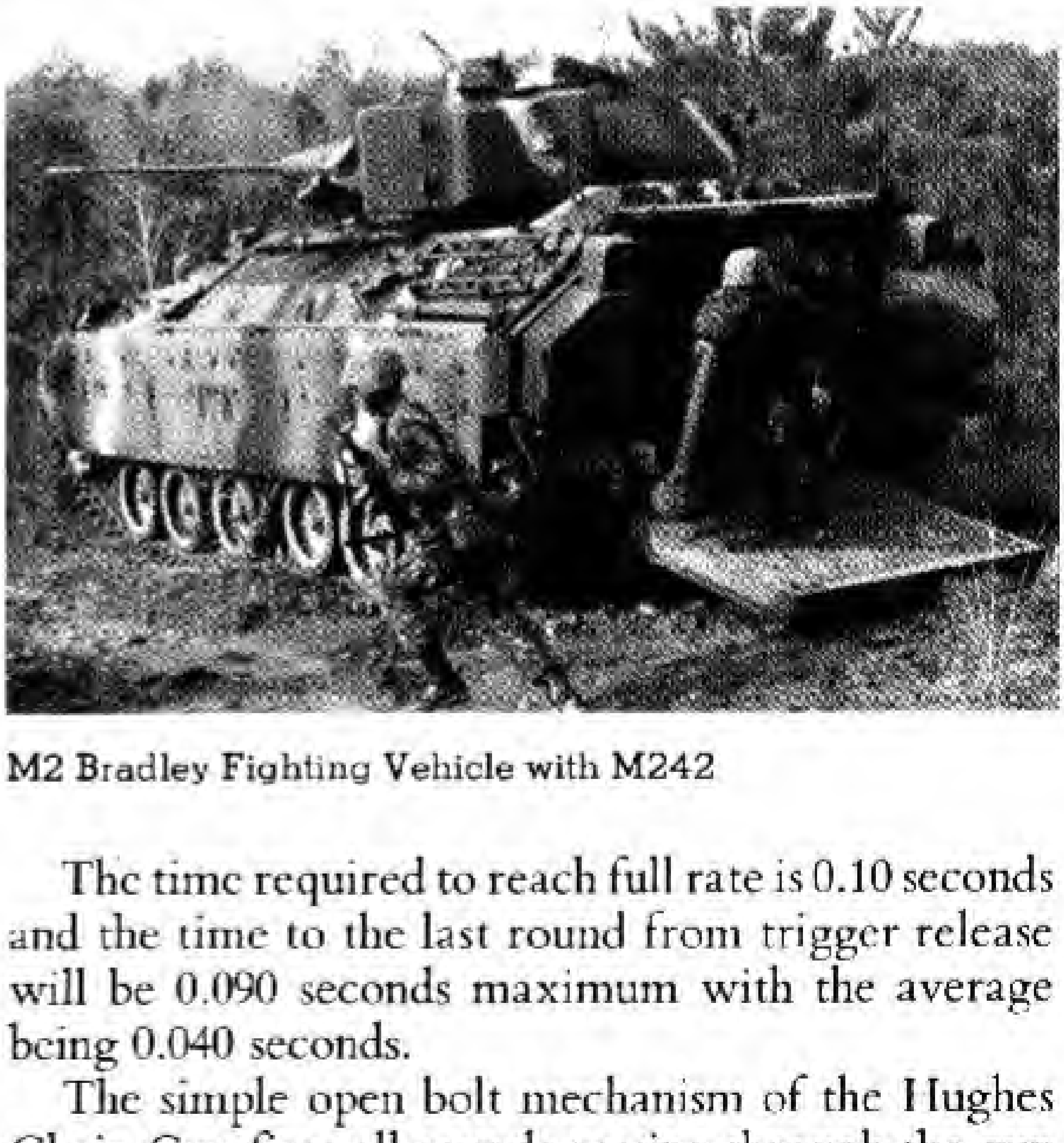
7.62mm EX-34 Chain Gun

AH-64 Apache with M230



United States Navy Mk 38 Naval Weapon System with M242 Cannon

United States Marine Corps Light Armoured Vehicle - 25 with M242



M2 Bradley Fighting Vehicle with M242

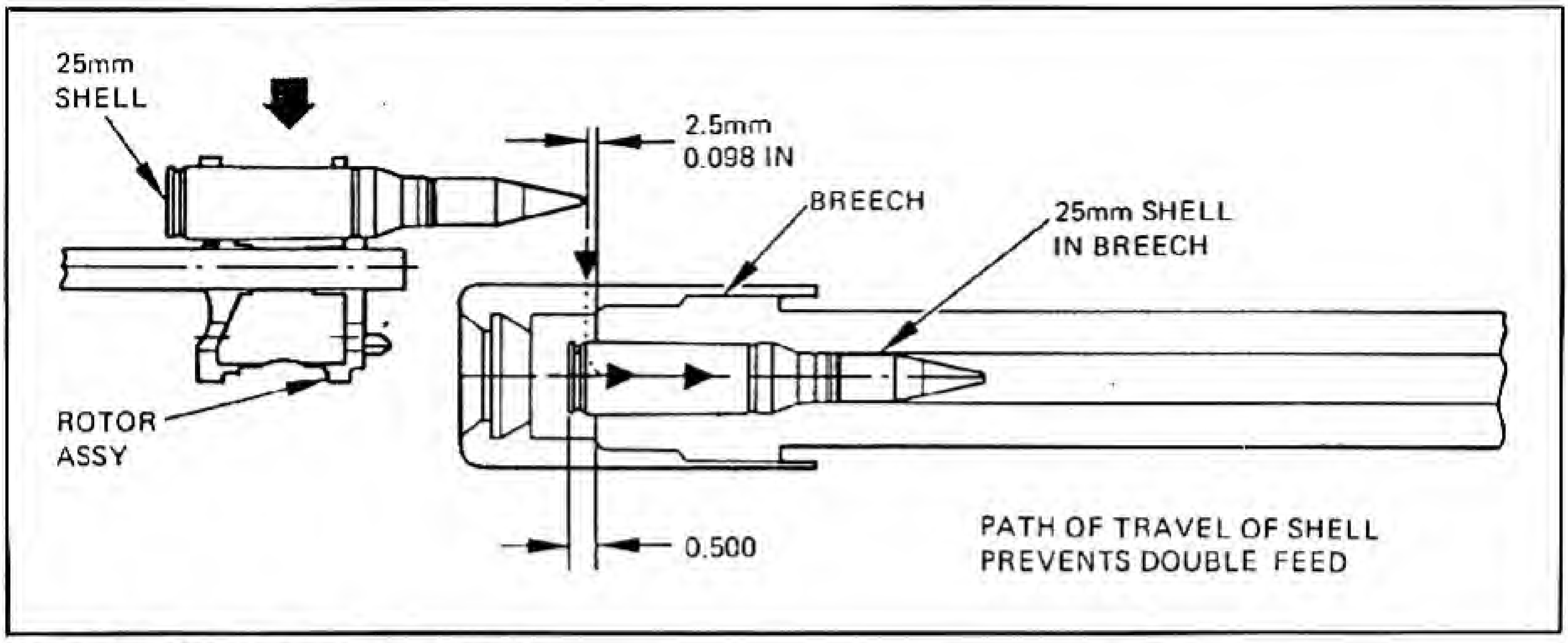
Chain Gun Cycle of Operation

The gun operates from an open bolt cycle, wherein the bolt is "seared" in its rearward motion at the end of each burst. Thus, no round is ever left in the chamber. No live rounds are ejected. As in any open bolt gun, the weapon stops in one-half cycle; having just fired one round and before chambering the next.

For safety purposes, a positive mechanical anti-double feed system is an integral part of the gun design. The ejection of spent cases and dud rounds is done by a powered rotor at a velocity of 20 fps.

The time required to reach full rate is 0.10 seconds and the time to the last round from trigger release will be 0.090 seconds maximum with the average being 0.040 seconds.

The simple open bolt mechanism of the Hughes Chain Gun fires all rounds passing through the gun and requires no clearing function, thus dispensing with the need and complexity/cost of a declutching feeder.



Feed Path Makes Double Feed Impossible

An absolute minimum of electrical circuits are included with this gun. The gun itself has only one motor and one mechanical switch, both of which are suitably protected from either generating electrical interference or being affected by it.

Loading and downloading of the gun is accomplished by a mechanical disconnect and hand crank. Failsafe design will prevent the possibility of inadvertent firing. An electrically released mechanical brake within the gun motor will prevent any motion of the gun parts until firing voltage is received at the motor. All parts are positively located and interlocked; additionally, there are no spring loaded sears or pawls which could be shaken loose by vibration.

Since this weapon does not depend upon the impulse of the cartridge for part of its operational cycle, temperature induced variations in ballistics will not affect its operation. Mechanically, the mechanism has no hydraulics and is straightforward and independent of temperature extremes.

The proposed mechanism is environmentally permissive, particularly those parts which are exposed to dust and sand. All gear boxes and bearings are sealed units.

The Chain Gun derives its extremely light characteristic through basic design and simplicity, rather than through use of highly stressed parts. As a result, parts are few in number, exhibit very low stress and long life characteristics. It is far easier and more practical to design long life into a gun having only 180 parts compared to guns having two to four times that many.

Blast suppression can be simpler and more effective to a single barrel gun. Hughes has had long experience developing blast and flash suppression equipment for aircraft. Since barrel weight is not a factor in the operation of the Chain Gun, maximum advantage can be made of their expertise in the reduction of blast using a modified blast profile directional muzzle brake.

Firing pin energy twice that required by the primer is available in the firing pin spring. Depth of penetration and concentricity are closely controlled by positive location and headspacing techniques.

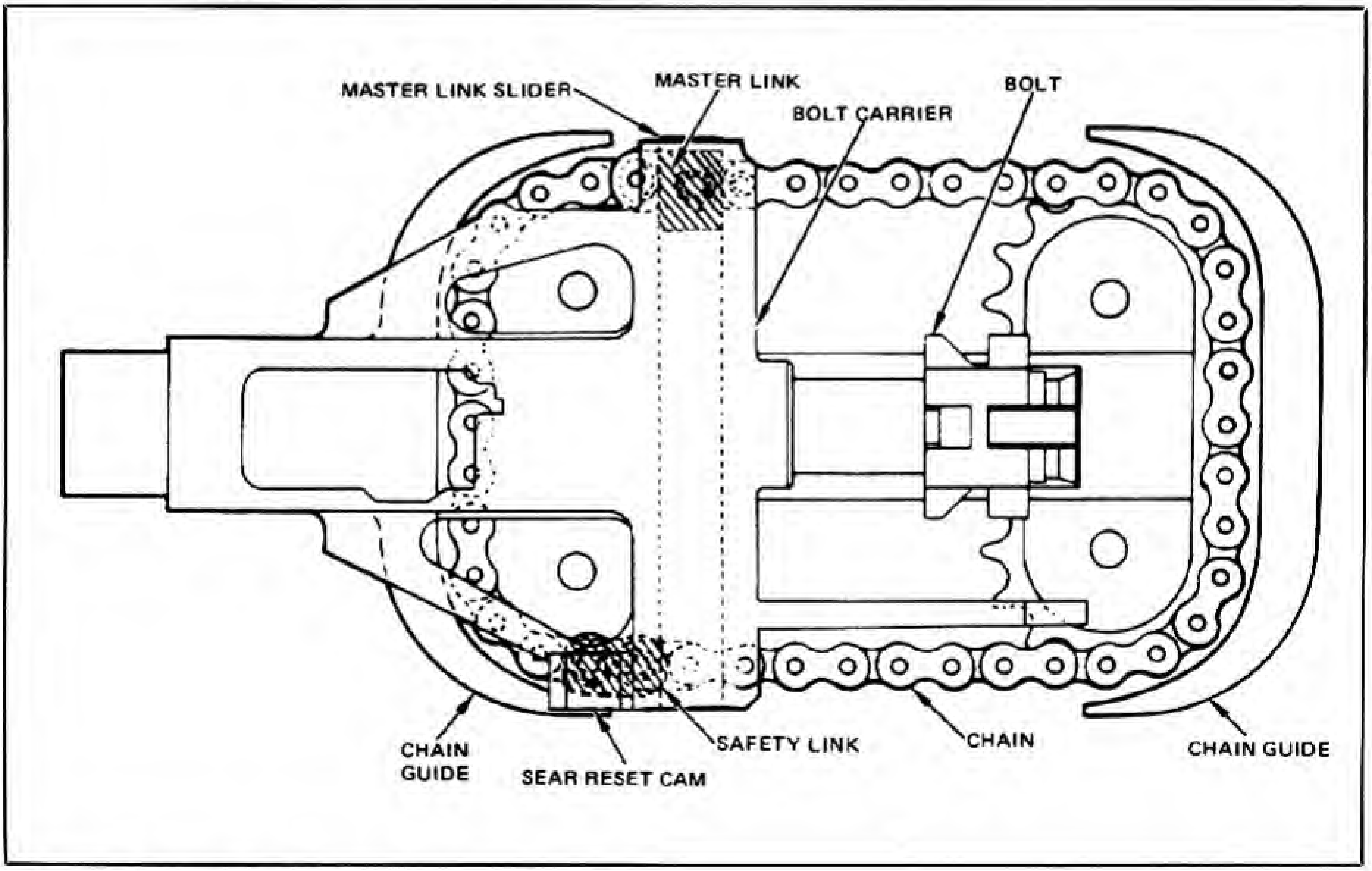
Chain Gun operation will be unaffected by altitude; the only element sensitive to this environment is the drive motor which will be suitably insulated for high altitude operations.

Suitability for Attack Helicopter

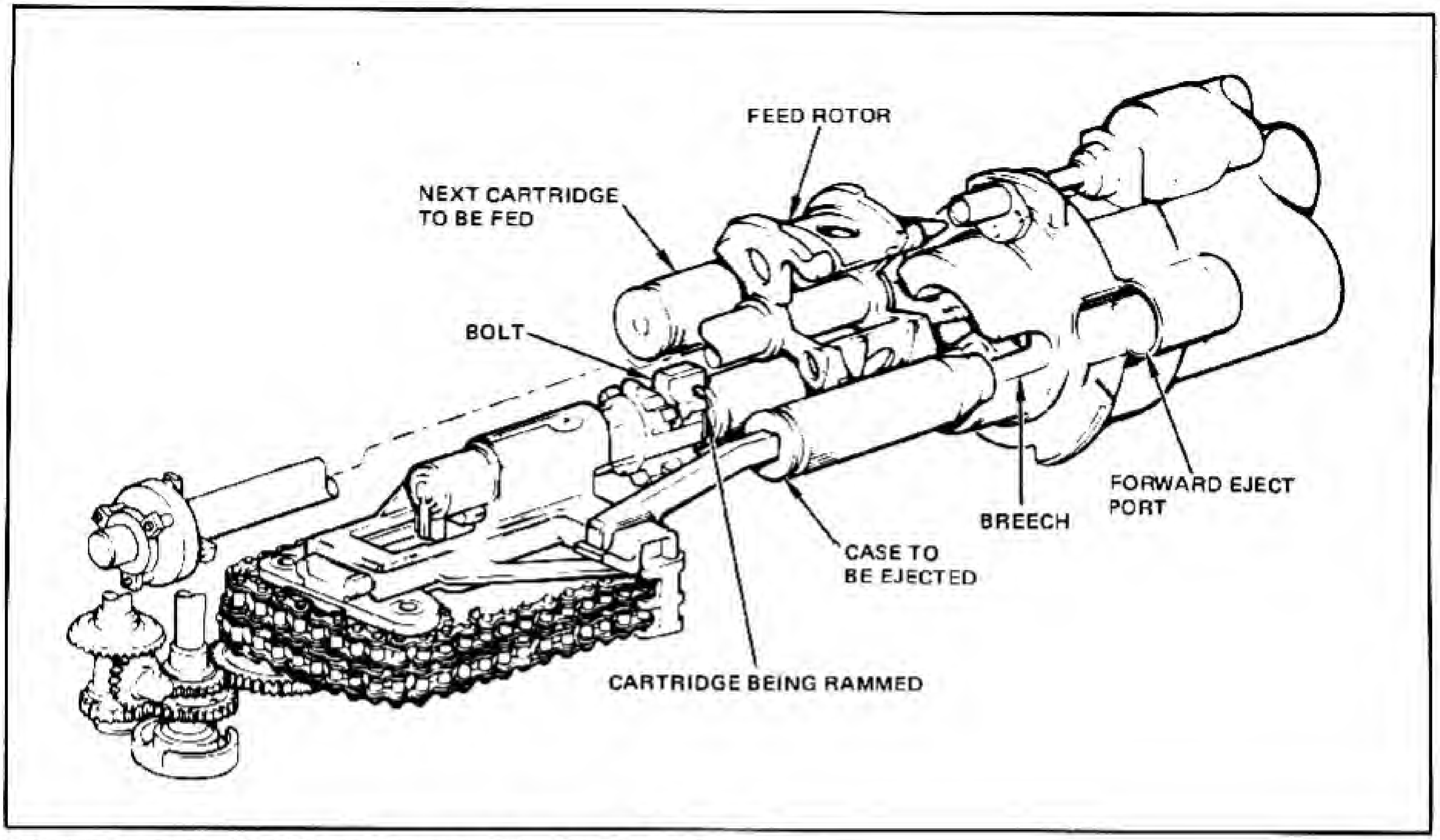
To ensure suitability of the Chain Gun for the close air support role of all attack helicopters, many factors were considered. Some, such as double feed protection and proper handling of misfires, are well identified in all safety flight requirements. Others, such as rate control, aerodynamic drag characteristics and system weight, significantly affect overall mission profile and must be addressed during the total system evaluation. All such factors, together with their impact on helicopter suitability, are briefly outlined in the following paragraphs.

Accuracy. The accuracy of the Hughes Chain Gun system is constant and does not depend on burst length or rate of fire. This is one of the primary advantages of a single barrel non-rotating system, since no varying tangential velocity is imparted to the projectile because of start-up, firing or changing rate of fire. Additionally, the multiple barrels of a Gatling mechanism are generally pointed inward at the muzzle and any variation in the exact angular position of the barrel at the instant of bullet exit will result in a different point of impact. This effect is accentuated by the use of percussion primed ammunition.

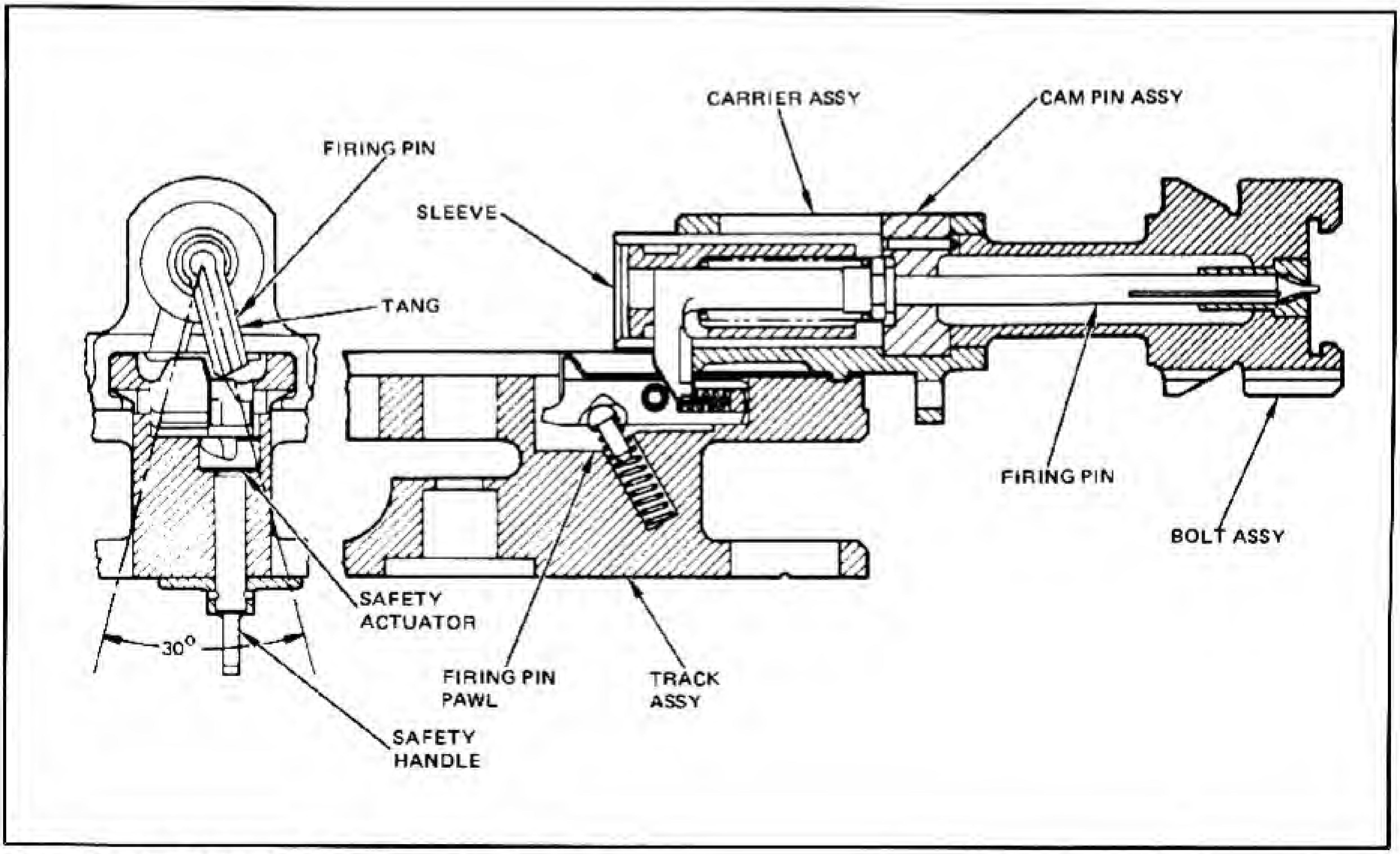
Double Feed. It is imperative that any gun system firing high explosive ammunition be rendered incapable of ramming one high explosive projectile into the base of the previous round. If this is allowed to happen, a high order detonation of the second warhead is possible and a flight hazard is present for the aircraft. To prevent this occurrence, an anti-double feed mechanism is designed into the Hughes Chain Gun. This mechanism invovles an extension to the transfer sprocket shaft and a sensing rotor in the barrel extension. The sensing rotor is scalloped out such that, as the rounds are rammed, they pass under the scallops into the chamber. If, during extraction, there is a failure to extract and the case remains within the chamber, this sensing rotor prevents further rotation of the transfer rotor by jamming against the head of the unextracted case. This positively prevents the chambering of any further rounds and will, through the action of a thermal limit switch within the stalled drive motor, prevent further operation or failure of the gun system. This anti-double feed system is entirely mechanical and requires no sensors or electronic circuitry, thus ensuring maximum reliability and maintainability and minimum interference with the gun system during normal operation.



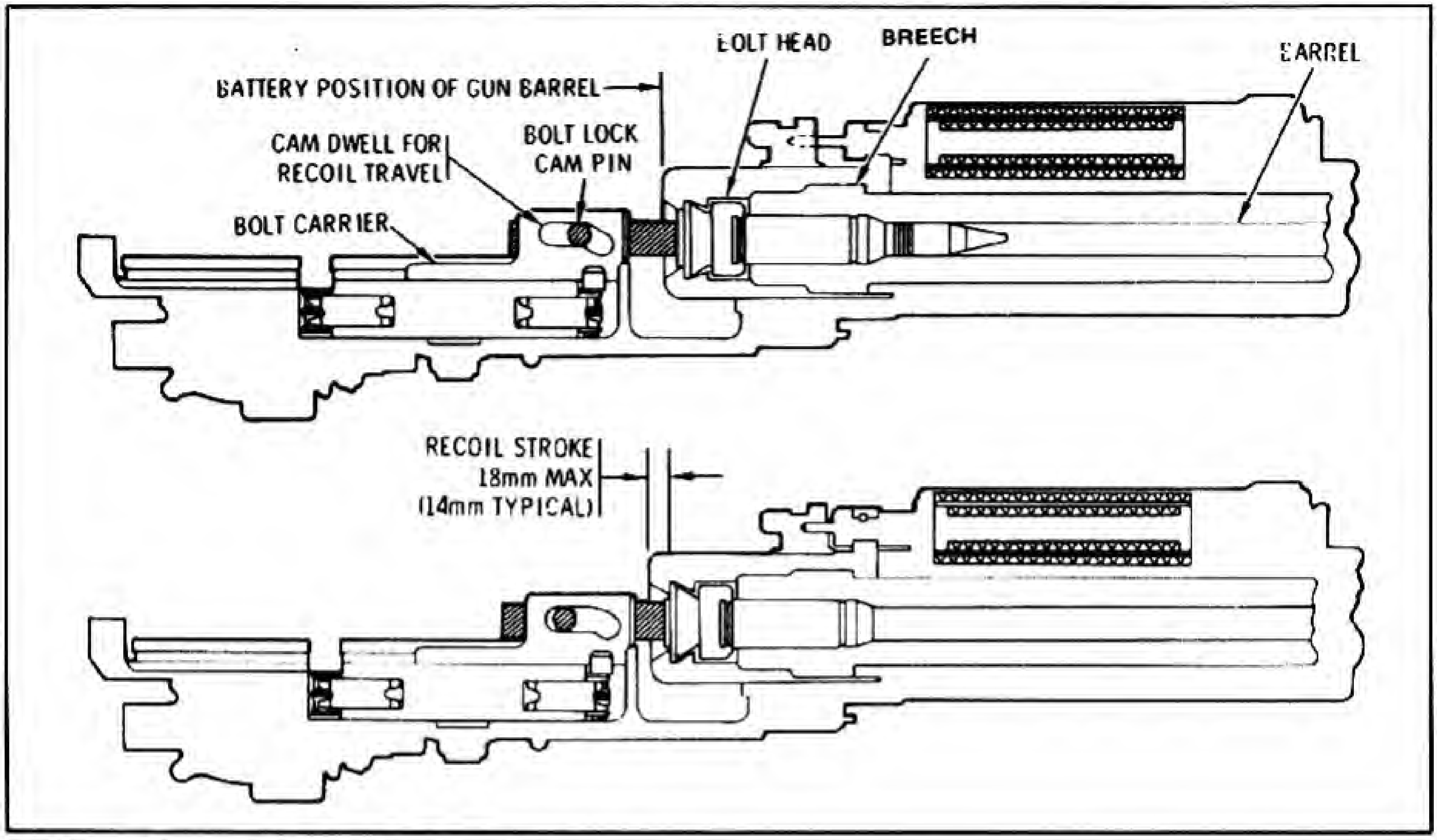
Schematic View of the Chain Drive


FEED ROTOR
NEXT CARTRIDGE TO BE FED
BOLT
FORWARD EJECT PORT
BREECH
CASE TO BE EJECTED
CARTRIDGE BEING RAMMED

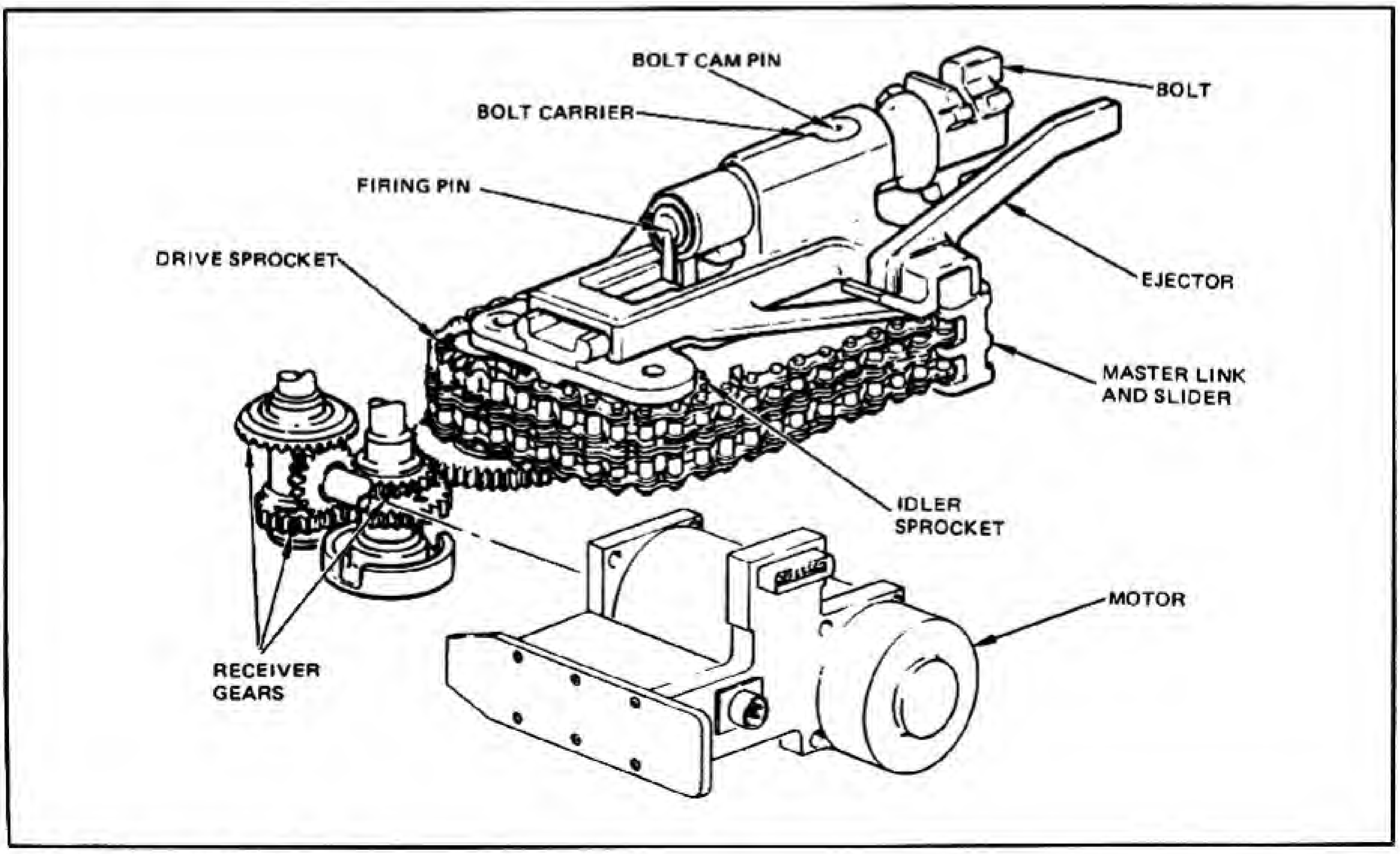
Relative Positions of Bolt, Barrel Extension, Feed and Rotor During Feed


CARRIER ASSY
CAM PIN ASSY
FIRING PIN
SLEEVE
TANG
FIRING PIN
BOLT ASSY
SAFETY ACTUATOR
30°
FIRING PIN PAWL
TRACK ASSY
SAFETY HANDLE

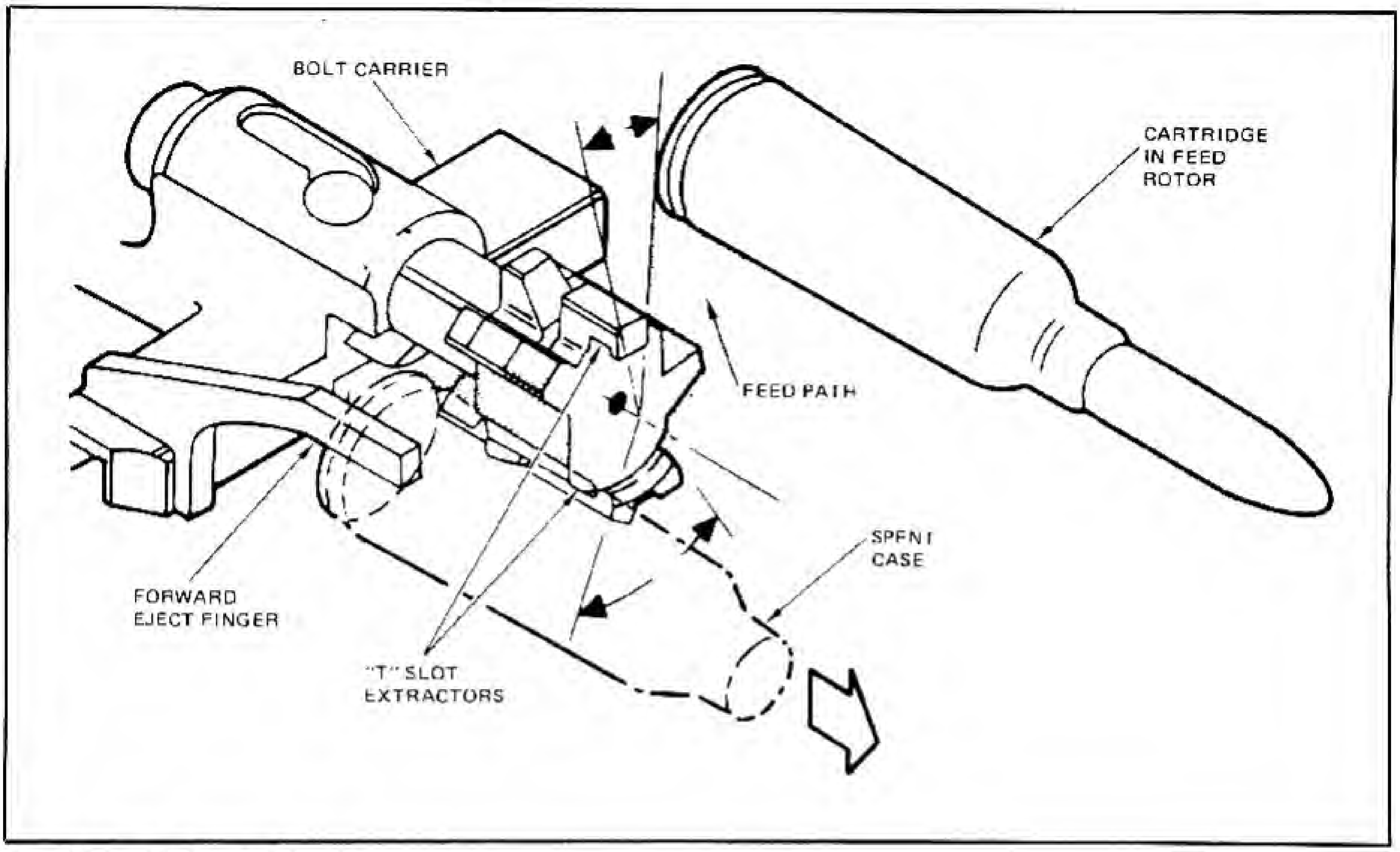
Cross Section of Bolt with Firing Pin - Firing Position


BOLT HEAD
BREECH
BARREL
BATTERY POSITION OF GUN BARREL
CAM DWELL FOR RECOIL TRAVEL
BOLT LOCK CAM PIN
BOLT CARRIER
RECOIL STROKE 18mm MAX (14mm TYPICAL)

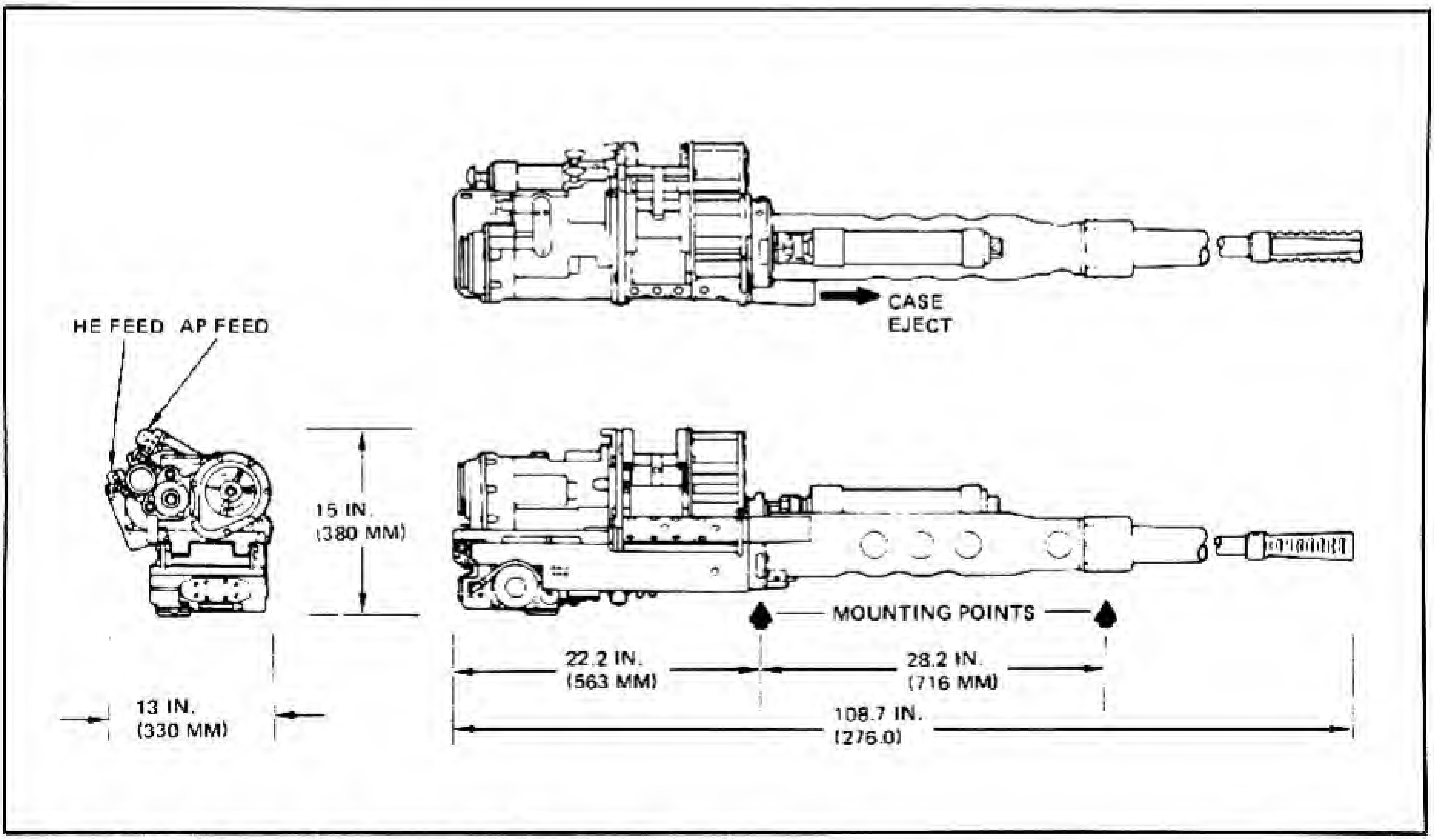
Operational Sequence of Chain Gun Barrel Recoil


BOLT CAM PIN
BOLT
BOLT CARRIER
FIRING PIN
DRIVE SPROCKET
EJECTOR
MASTER LINK AND SLIDER
IDLER SPROCKET
MOTOR
RECEIVER GEARS

Bolt Assembly with Chain Drive


BOLT CARRIER
CARTRIDGE IN FEED ROTOR
FEED PATH
SPENT CASE
FORWARD EJECT FINGER
"T" SLOT EXTRACTORS

Front View of Bolt with T-Slot Extractors


CASE EJECT
HE FEED
AP FEED
15 IN. (380 MM)
13 IN. (330 MM)
MOUNTING POINTS
22.2 IN. (563 MM)
28.2 IN. (716 MM)
108.7 IN. (276.0)

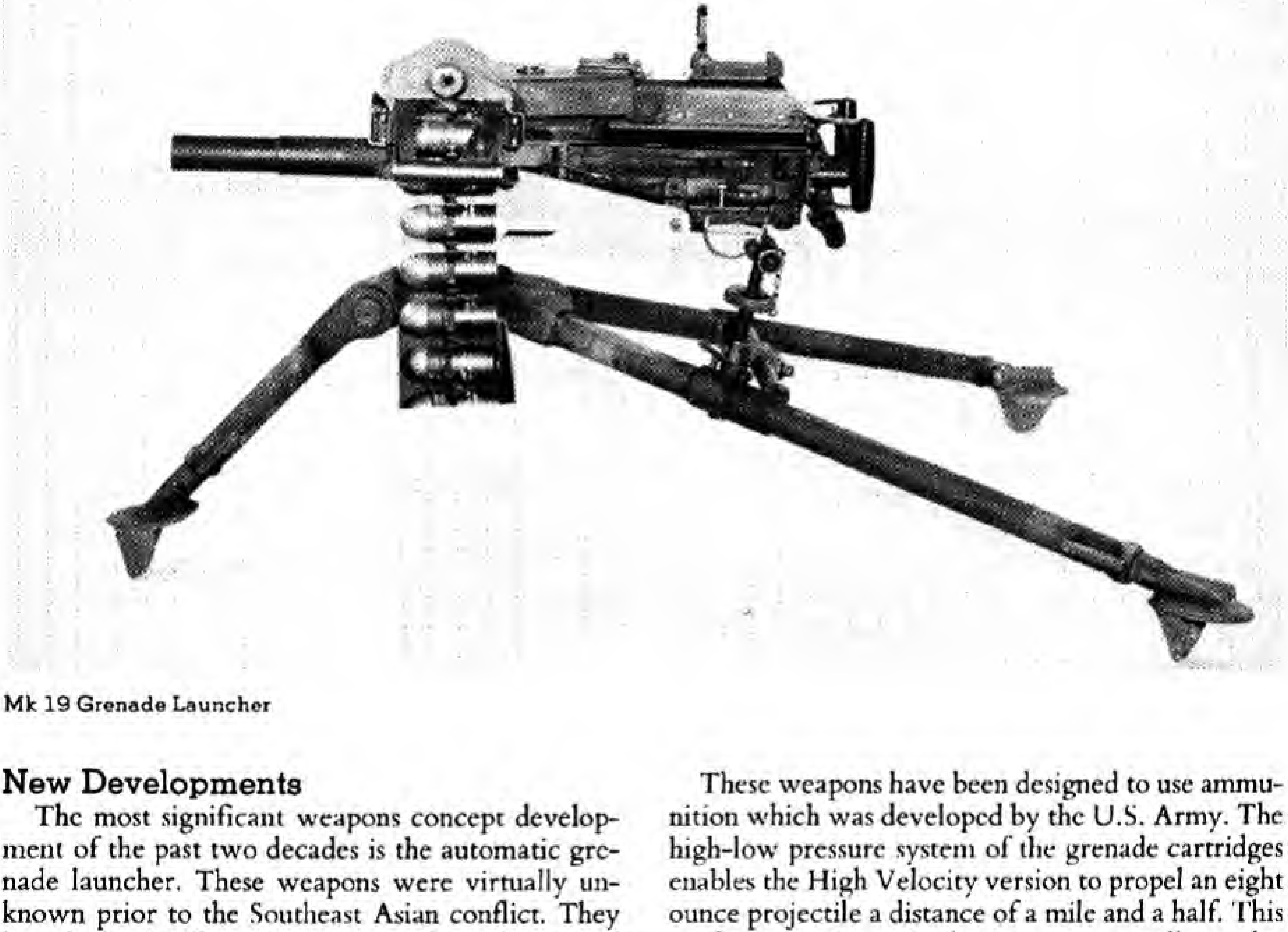
Dual-Feed XM242 Chain Gun Interface Control Drawing

PART XV

GRENADE LAUNCHER MACHINE GUNS

Chapter 57

THE GRENADE LAUNCHER STORY



Mk 19 Grenade Launcher

New Developments

The most significant weapons concept development of the past two decades is the automatic grenade launcher. These weapons were virtually unknown prior to the Southeast Asian conflict. They have had a significant impact upon the antipersonnel tactics employed by the armed forces.

The development of the grenade launcher concept has been closely related to the increased military use of small boats and helicopters as well as to the need for better fixed position and vehicular defense. A number of grenade launcher weapons have been developed with varying degrees of success.

These weapons have been designed to use ammunition which was developed by the U.S. Army. The high-low pressure system of the grenade cartridges enables the High Velocity version to propel an eight ounce projectile a distance of a mile and a half. This performance is attained using a very small powder charge, about equivalent to that used in the calibre .44 Smith & Wesson revolver cartridge. The high-low pressure concept was also proposed for even larger calibre weapons.

The emphasis then was on the development of 40mm grenade launchers. There are two types of these weapons, one uses high velocity and the other low velocity ammunition. The terms high and low velocity are relative with respect to grenade launchers because both types are relatively low velocity when conpared with a conventional round of 40mm ammunition.

The need for rapid firing grenade launchers for infantry use resulted in several design configurations, such as the Mk 18, XM174, and the Mk 20, all of which utilize low velocity ammunition. These will be discussed in order of production.

The Mk 18 is a hand-cranked weapon of unique design. However, it had a serious drawback, the fact that the weapon must be operated while the gunner is on his knees which is, of course, an extremely dangerous stance in a combat situation.

The XM174 is a fully automatic weapon which functioned reliably. However, since the magazine has a capacity of only 12 rounds, its effectiveness is limited to a degree that eliminated it as a serious contender.

The most advanced low velocity grenade launcher that was developed to date is the Mk 20. The weapon is belt-fed and utilizes an ingenious blowback/blow-forward system of operation and proved under all conditions to be extremely reliable.

The high velocity grenade weapons such as the M75, XM129, XM173, XM175 and the Mk 19 more than double the effective range of the low velocity weapons and are particularly suited for vehicular applications. Their greater weight and bulk, limit their use by individual infantrymen.

The M75 grenade launcher was developed for use in helicopter turret armament systems and utilizes an externally powered drum to perform the functions of feeding, locking, firing, and ejection of belted ammunition. The XM129 is a refined version of the M75 and is used in similar applications.

The XM173 is an XM129 grenade launcher adapted to a hand-cranked power source for infantry use. The basic design of these three weapons is not new but the application to grenade launchers is original.

The XM175 and Mk 19 grenade launchers are reciprocating automatic weapons and hence were considered more suitable for conventional vehicular mounting as well as fixed position defense than are the other power driven high velocity grenade launchers. Unfortunately, a design problem rendered the XM175 unreliable and therefore ineffective. However, during the early stage of the Vietnam War, the Mk 19 had been declared combat proven and rated worthy of military adoption.

ARMY PERFORMS MIRACLE IN MUNITION DESIGN

While American industry has been making incremental advances in consumer products, the designers and producers of U.S. military munitions quietly achieved major breakthroughs in lethality and cost effectiveness. The spectrum of these new munitions range from small-arms rounds to large-calibre artillery shells as well as missile and rocket warheads. An example of such an engineering miracle is the 40mm grenade round in its several configurations. The principles, techniques, and successes achieved in this case are applicable to all calibres above 30mm.

The Army spends up to 50 percent of its logistic dollar on combat ammunition. It demands extraordinarily high standards of safety in these explosive systems. It requires that they work perfectly and immediately after extended storage and in the diverse climates and environments, from the Arctic to the South Pacific, in which our troops may have to fight.

These requirements for exceptional performance characteristics must be met during a conflict by very large scale production of millions of rounds at unprecedented rates. At the same time, the costs must be continually driven down and performance improved.

The techniques used to accomplish these goals are significantly different from those used in industry or for other military commodities. The magnitude of the effort required involves a broad cross section of American and sometimes foreign industry, academic, and Government. The 40mm story shows the intimate and productive interrelationships which were developed under DOD laboratory leadership to culminate in a successful munitions program.

During the early 1950's, it was proved that the anti-personnel effectiveness of munitions could be significantly increased if the fragmentation characteristics were designed and controlled to match the vulnerability of the target. At the same time, discussions with combat infantrymen also revealed that

30MM
40MM
40MM
GRENADES

30mm, 40mm Grenades

they needed a new system to deliver effective area firepower at a range greater than that available with the conventional hand grenade.

Analytical and engineering prototype studies confirmed that a 40mm controlled fragmentation projectile could be readily launched 437 yards with a simple, low-momentum weapon. It therefore appeared possible to equip the infantry with a weapon system of exceptional firepower effectiveness.

The translation of conceptual and prototype studies to low-cost, versatile, safe munitions that can be manufactured and distributed to the troops in large numbers is a complex and costly effort. Ideas were sought from several sources: in-house, industry, and the academic community. Foreign developments were also examined for their applicability. The problem involved essential requirements of quantity, cost, safety, and large-scale manufacturability with the performance requirements for creating effective, on-target firepower.

The result was a simple, safe, trouble-free projectile for the infantryman. However it incorporated major technical advances including controlled fragmentation, sensitive high-performance impact fuzing, a high-low pressure propulsion system, and a special lightweight cartridge. Minimum cost and adaptability to automation also had to be designed into the system in view of the extraordinarily large usage anticipated.

To accomplish these goals, an in-house Government group of design, product, process, maintenance, and quality-assurance engineers were assembled under project management at Picatinny Arsenal, Dover, N.J., to work closely as an integrated team with a wide variety of industrial organizations and members of the academic community. A systems engineer was selected to direct the program, to coordinate interface problems, and particularly to focus on performance and cost.

The cost element was predominant and considerable effort was made to effect a cyclic interplay between design and industrial engineers. This approach is particularly critical in munitions design, not only to reduce costs but to fabricate efficiently the 15,000 projectiles required for test and evaluation and to develop the beginnings of a sound technical-data package.

As an example, the initial Government approach to obtain controlled fragmentation called for the incorporation of small steel ball bearings in a matrix or sandwich construction. It was quickly evident that the enormous quantities required would exceed the capacity of the ball-bearing industry.

The Stanford Research Institute successfully established a simple, low-cost procedure for producing small, uniform fragments from preengraved sheet stock which enabled the lethal effectiveness of the ball bearing approach to be matched.

This technique was adopted by the Avco Corporation, using a unique tool steel developed in Czechoslovakia, to fabricate the preengraved stock by a "roll coin" process. A final modification which again reduced cost was developed by the Chamberlain Manufacturing Corporation—a fragmentation body made from copper-brazed notched wire.

At the same time, development at Honeywell Inc., produced a superior fuze with a longer arming delay which the infantry demanded. Throughout the development cycle, engineers and scientists from Picatinny, Frankford, Edgewood, and the Ballistic Research Laboratories made important contributions. Testing was conducted at Aberdeen and Jefferson Proving grounds and by the U.S. Army Infantry Board at Fort Benning. Simulated combat tests against a variety of realistic targets were run by the Combat Development Experimental Center at Fort Ord, using a plan proposed by the center in collaboration with personnel from Johns Hopkins and Picatinny Arsenal.

Although predictable delays occurred in finalizing design and developing essential low-cost manufacturing techniques, the new projectile, designated the M406, was successfully completed and type classified. A limited number of weapons and ammunition was made available to the troops, and performance was excellent.

When the Vietnam conflict began to escalate, the requirements for the M406 soared to unanticipated rates 42.6 million rounds in 1970. High-volume mass production was a matter of great urgency. New manufacturers, often inexperienced with the required components, rapidly entered the scene.

The integrated team's industrial engineers, who had resolved fabrication problems in the program's initial phases, were assigned to lead task forces to provide day-to-day technical support to new manufacturers. The technical-data package was continuously reviewed and updated, and the design was reexamined and modified to lower cost and improve performance, reliability, and safety. Changes were tested and incorporated wherever significant advantages could be obtained.

Techniques for large-scale manufacture of the unique aluminum cartridge case were developed by the Harvey Aluminum Corporation and the Amron Corporation in the United States and the General Impact Extrusion Corporation in Canada. The methods for making the lethal sphere metal parts assembly were established by the Heckethorn Manufacturing Company, Avco, Eisen Brothers, and the Eastern Metal Parts Corporation.

Honeywell designed and developed equipment for the automatic assembly of fuzes which incorporated naval inspection procedures. Amron, Dayron, and Honeywell developed additional techniques for fuze production, and a great many other companies worked out special processes for making the smaller components of the cartridge.

The Milan, Ravenna and Joliet Army plants established procedures, based on prototype production at Picatinny, for explosive loading and assembly of the completed cartridge.

These combined efforts enabled the Army to meet the accelerating requirements of its combat infantry troops with effective munitions at minimum cost. As an example, the extraordinary decrease in cost of the 40mm fuze went from approximately $1.75 in 1962 to 50 cents in 1972. Simultaneously, reliability increased from 94.6 to 99.3 percent.

Most important, an impressive safety record was established. More than 140 million rounds were fired without any major failures or injurious premature detonations. Equally significant, the continuous feedback to design engineers of ideas and interaction with the user enabled the Army's laboratories to evolve successive designs of substantially increased performance with little cost increase.

The availability of a large number of weapons in the field and in stockpile involves a major investment which must not be discarded without great justification. A cardinal principle in munitions innovation is that it shall be evolutionary and shall involve a minimum of weapon changes.

The design of radically new systems, such as the 40mm grenade launcher, is at times the logical and necessary result of major technological advances. However, after the first major innovation, evolutionary development of munitions can result in substantial improvements and economies.

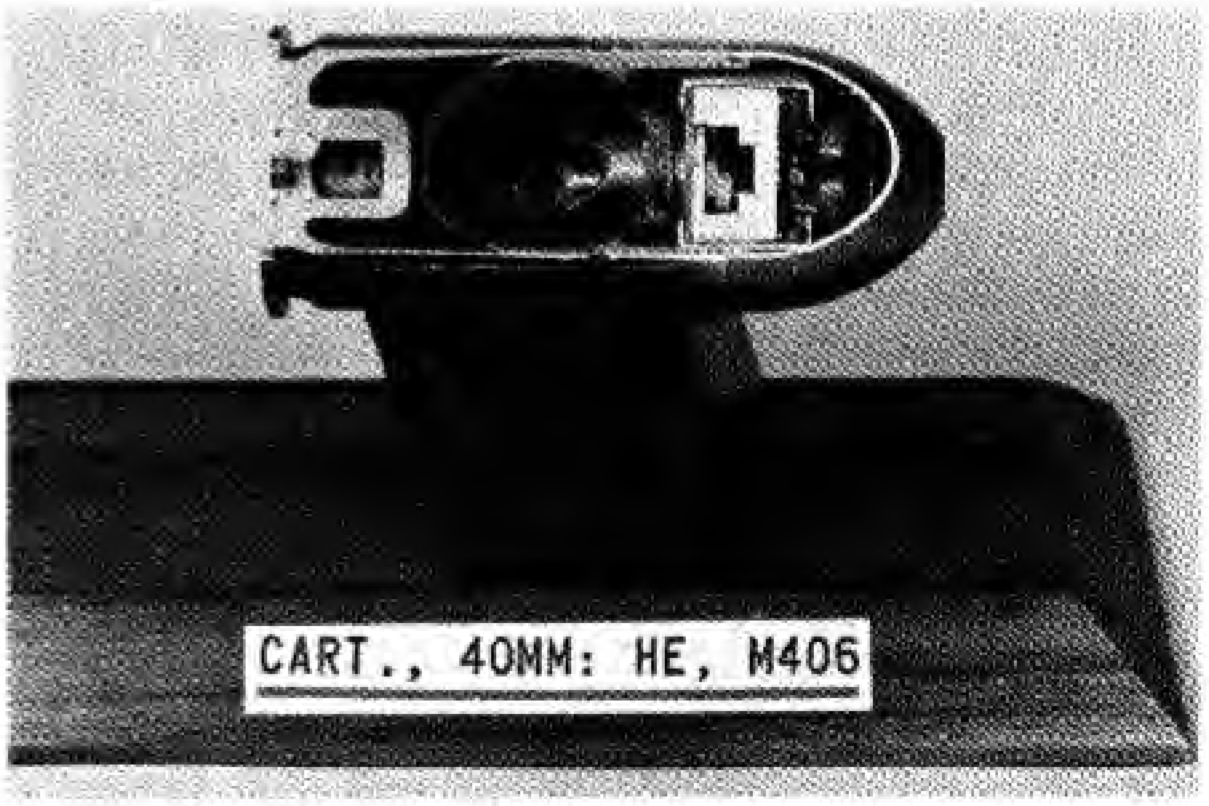
Major performance gains can be made through appropriate product-improvement programs designed to modify current systems with changes well within the domain of existing technological capabilities.

The widespread acceptance and usefulness of the 40mm grenade system led to the first new design step for increased antipersonnel munitions capability. When the M406 grenade exploded on impact many lethal fragments went into the ground. Effectiveness would be doubled if the projectile could burst in the air.

This problem was solved through conception and development of a new fuzing approach using the same propulsion system, cartridge case, and explosive fragmentation body as in the standard M406 grenade and doubled its effectiveness at a price increase of less than 10 percent!

This development enabled most know-how and cost-saving techniques incorporated in the technical data package to be maintained. It also offered a major advantage in providing the infantry with the substantial increase in antipersonnel firepower effectiveness without the necessity for additional training.

It also had become increasingly apparent that



Cartridge, 40mm HE M406

there was an important need to provide the infantry with firepower to meet the increased threat from light material such as armored troop carriers, self-propelled artillery, and other combat vehicles. This requirement also was met using previously developed managerial techniques: a life-cycle integrated team of system engineers, a project manager, and an evolutionary design approach.

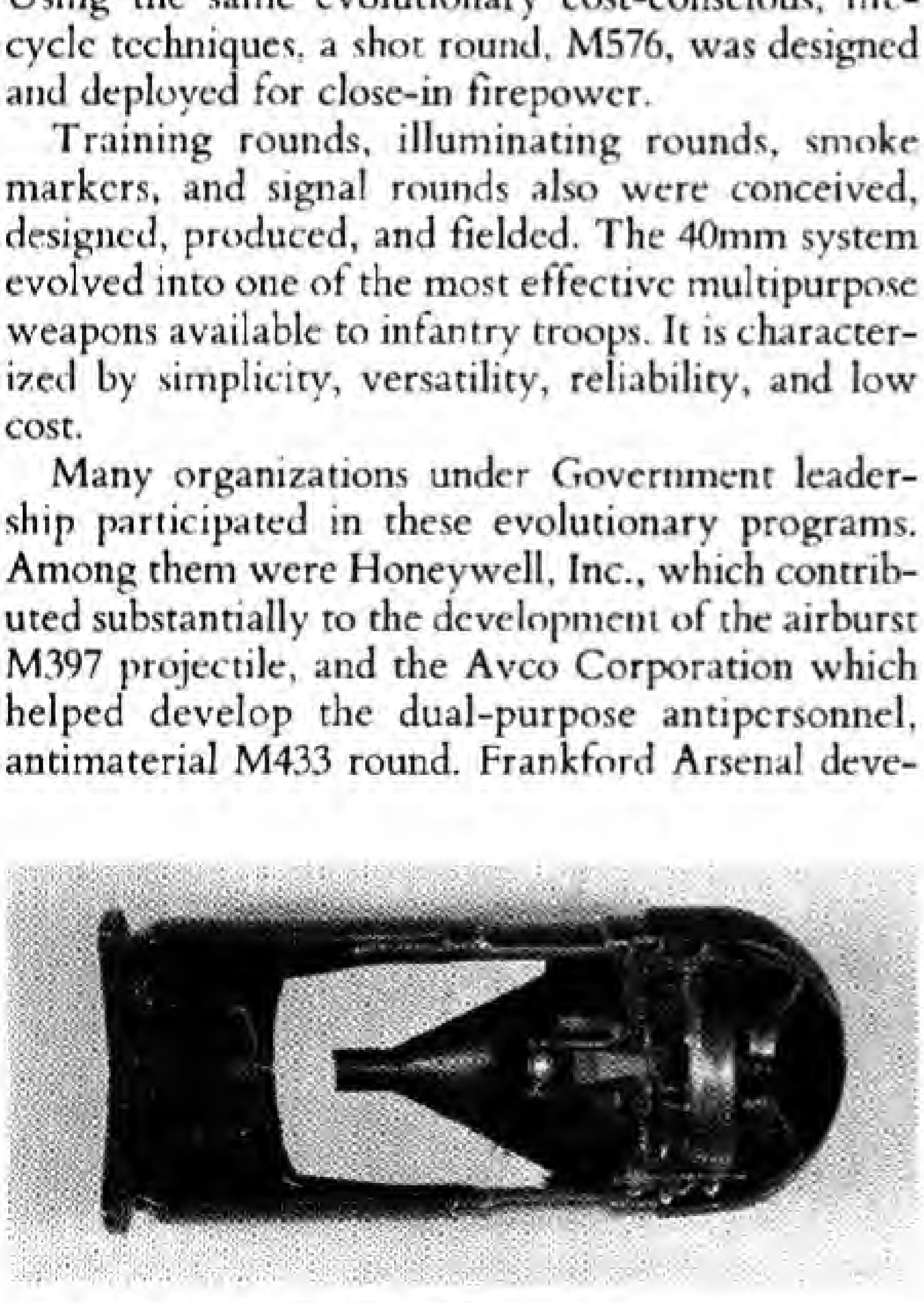
The conceptual breakthrough involved the use of novel fuzing and the incorporation of a high-efficiency shaped charge in the 40mm round. Both performance and cost goals were met. The dual-purpose M433 projectile was type-classified in 1970.

Here again, even with its markedly increased performance capability, the cost of the M433 projectile was only about 15 cents more than the M406. It is lethal against personnel, light battlefield material, and many protected positions.

The Mk 19 Mod 1 grenade launcher and 40mm explosive munitions provided the infantry with an effective weapon system. A spectrum of munitions was sought to increase the weapon's field versatility. Using the same evolutionary cost-conscious, life-cycle techniques, a shot round, M576, was designed and deployed for close-in firepower.

Training rounds, illuminating rounds, smoke markers, and signal rounds also were conceived, designed, produced, and fielded. The 40mm system evolved into one of the most effective multipurpose weapons available to infantry troops. It is characterized by simplicity, versatility, reliability, and low cost.

Many organizations under Government leadership participated in these evolutionary programs. Among them were Honeywell, Inc., which contributed substantially to the development of the airburst M397 projectile, and the Avco Corporation which helped develop the dual-purpose antipersonnel, antimaterial M433 round. Frankford Arsenal developed the M576 shot round, and Avco, Kilgore, MB Associates, and the Longhorn Army Ammunition Plant all were deeply involved with the development of the various 40mm signal cartridges. Ground smoke signal cartridges also were developed by Calspan Corporation using a unique impact-functioning pyrotechnic fuze conceived by the Cornell Aeronautical Laboratory. Basic work by the AAI Corporation on plastic cartridge cases was extended to develop low-cost 40mm training cartridges.



Cartridge, 40mm HEDP M433

CART., 40MM; HE, M384

Cartridge, 40mm HE M384

Further extrapolations continued. A 40mm rapid-fire grenade launcher was developed for Army helicopters to provide pilots with extensive area firepower against enemy targets. Again, the 40mm antipersonnel explosive grenade was redesigned, this time with a novel propulsion charge which extended its range from 400 to 2,000 meters. As conceptual advances continued, a new design was evolved to permit helicopters successfully to attack light material as well as personnel.

Here too, the Government-industry team was notably successful in extending the usefulness of the 40mm system to Army helicopters. The Aerojet Corporation participated in the development of the M383 and M384 high-explosive, antipersonnel fragmentation cartridges with support from Honeywell on the fuze required for these projectiles. Avco Corporation took the next step and developed the M430 dual-purpose antipersonnel antimaterial cartridge.

To facilitate increased capabilities of the 40mm munitions, the M79 grenade launcher was replaced by the M203 launcher attached to the M16A1 rifle. The new weapon system gave the infantryman the capability to defeat point and area targets ranging from personnel to armored carriers and fortified positions. Work continues to develop 40mm automatic machine-gun-type weapons capable of being mounted on vehicles and watercraft.

Conceptual creativity in munitions arises from many sources: in-house Government laboratories, industry, the academic community, and foreign developments. The function of the Government munitions community is to create, stimulate, catalyze, and evaluate new concepts and to provide the necessary program management leadership and continuity.

Breakthrough discoveries and the notable success and continuing progress of the gun launched 40mm program can be attributed to the participation by a great diversity of competent organizations in all aspects of the work.

Munitions technolgoy is unusual and finds little precedent in consumer, industrial, or other military undertakings. In times of war, untried industrial producers must be used to meet great surges in requirements. The know-how gained through design, fabrication, and testing of large quantities of munitions must be rapidly transferred to industrial manufacturers so they can produce a safe and reliable product in the quantities required. Knowledge gained in this process is fed back to the designers, resulting in major gains in performance, reliability, safety, and cost.

The 40mm grenade development illustrates an initial breakthrough that produced a most successful 40mm grenade, a new weapon system and new battlefield tactics. Subsequent intensive capitalization on the basic design resulted in further major increases in firepower at minimum cost.

THE 40mm MACHINE GUN

With the increasing American involvement in Vietnam, the U.S. Navy urgently needed a weapon that could deliver a high rate of suppressive fire at comparatively short ranges. This need arose when the Navy began to perform an increasing number of river patrols, which generally consisted of small craft working in restricted areas where enemy ambush was a major problem.

To meet this demand, the Navy turned its attention to the 40mm gun-launched grenade. Since the 1950's the Army and industry had been working on a gun-launched grenade system, resulting in a ballistic breakthrough hailed by many as a miracle.

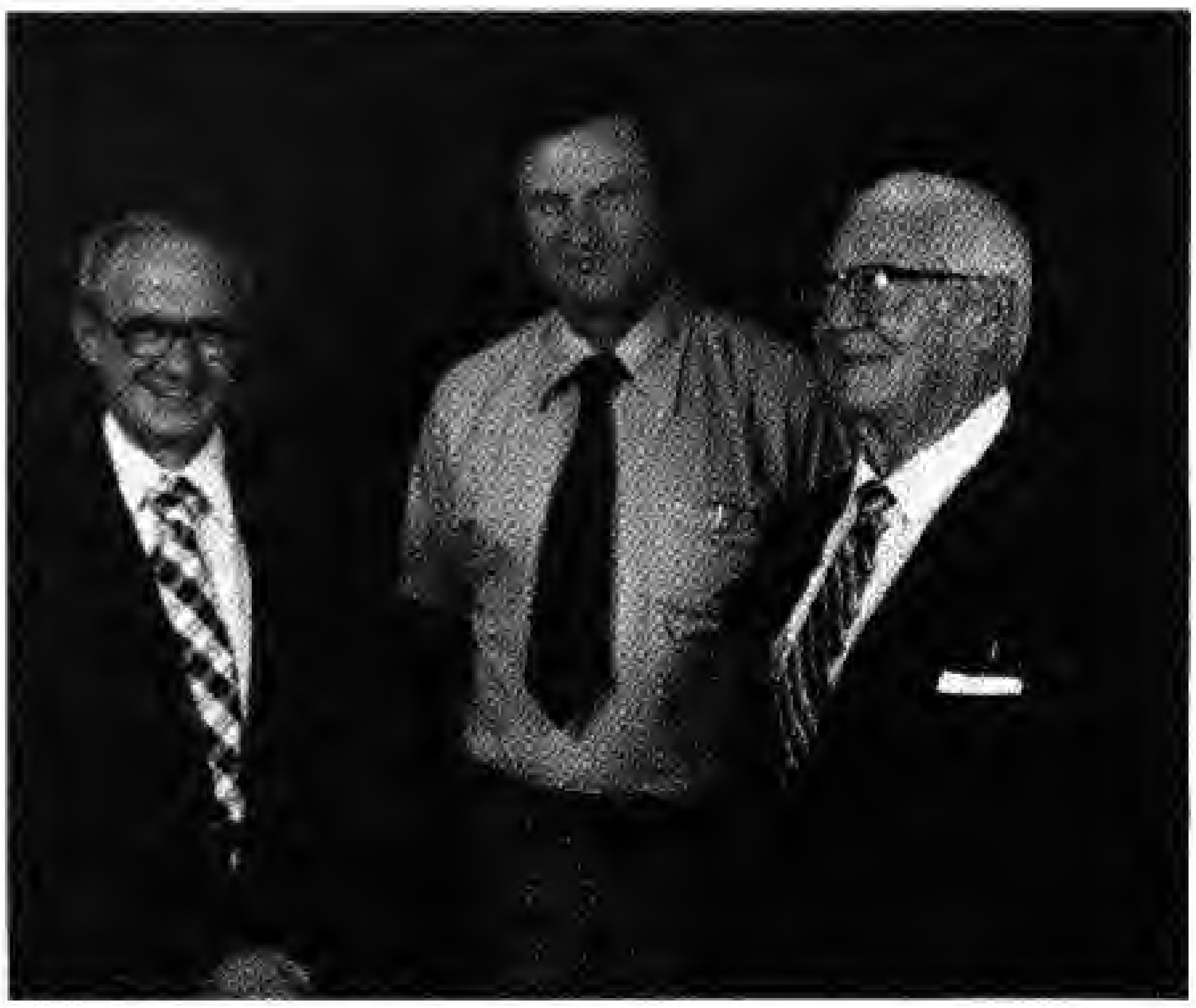
The shoulder-fired M406 grenade, a low-velocity projectile with a ⅜-pound warhead and a range of 400 meters, was a quantum jump in effectiveness over the conventional hand grenade. It was an Army development that in time perhaps will prove as important as George W. Morris' patent of May 11, 1858, that finally convinced the armies of the world it was possible to combine bullet, primer, and powder charge in a single metallic cartridge case.

The high-velocity M384 round, developed later, had a range of 2,200 meters but had too much recoil to be shoulder-fired.

The Army and Air Force had experienced over the years a series of successful weapon development programs with external power-driven mechanisms. Some of those were the Vulcan 20mm, GAU 30mm, and the rifle-calibre Mini gun, and the Army again turned toward this reliable method for utilizing its new M384 high-velocity 40mm grenade cartridge.

The weapon was officially designated the M129 and, in effect, gave limited artillery capabilities and permitted the rapid firing of fragmentation projectiles from helicopter gunships fitted with this highly efficient power-driven grenade launcher.

The Navy, however, wanted a more versatile weapon such as an automatic belt-fed 40mm machine gun with feeding, loading, firing, extraction, and



From left to right: Bill Schnatter, Engineer in Charge; Walter Cashen, Project Engineer; and George M. Chinn, Design Engineer for the Mk 19.

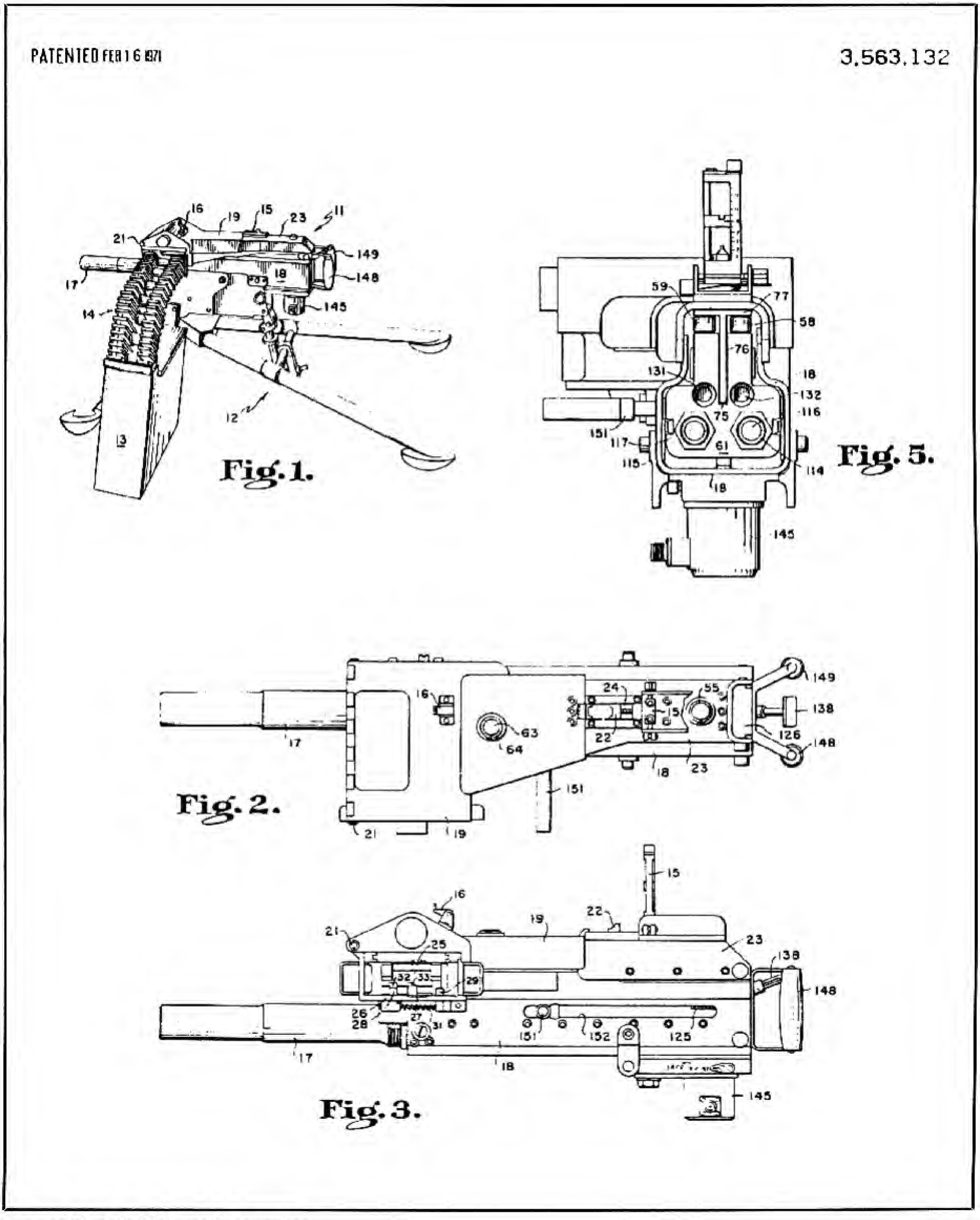


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Fig. 1.

Fig. 5.

Fig. 2.

Fig. 3.

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Patent of the Mk 19 Grenade Launcher

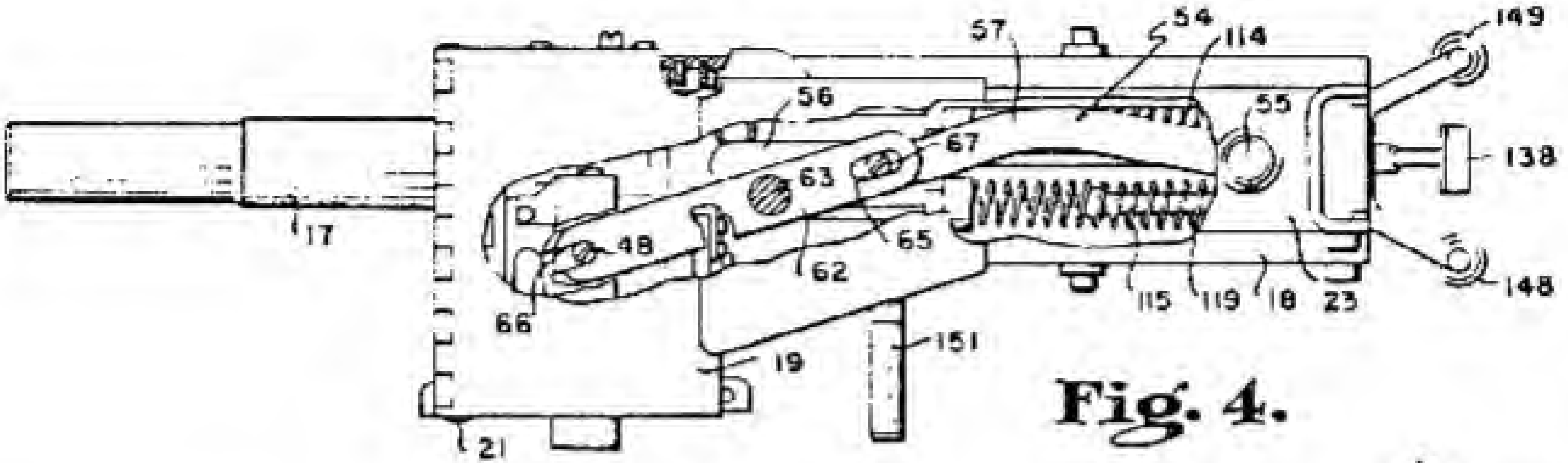
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Fig. 4.

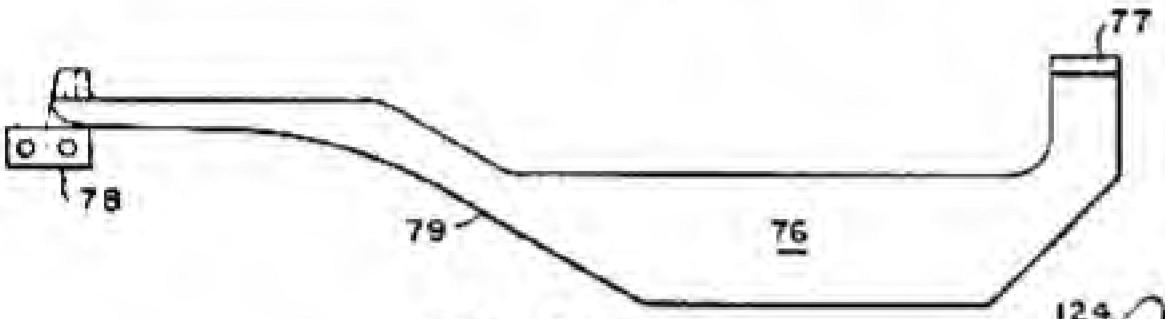

Fig. 9.

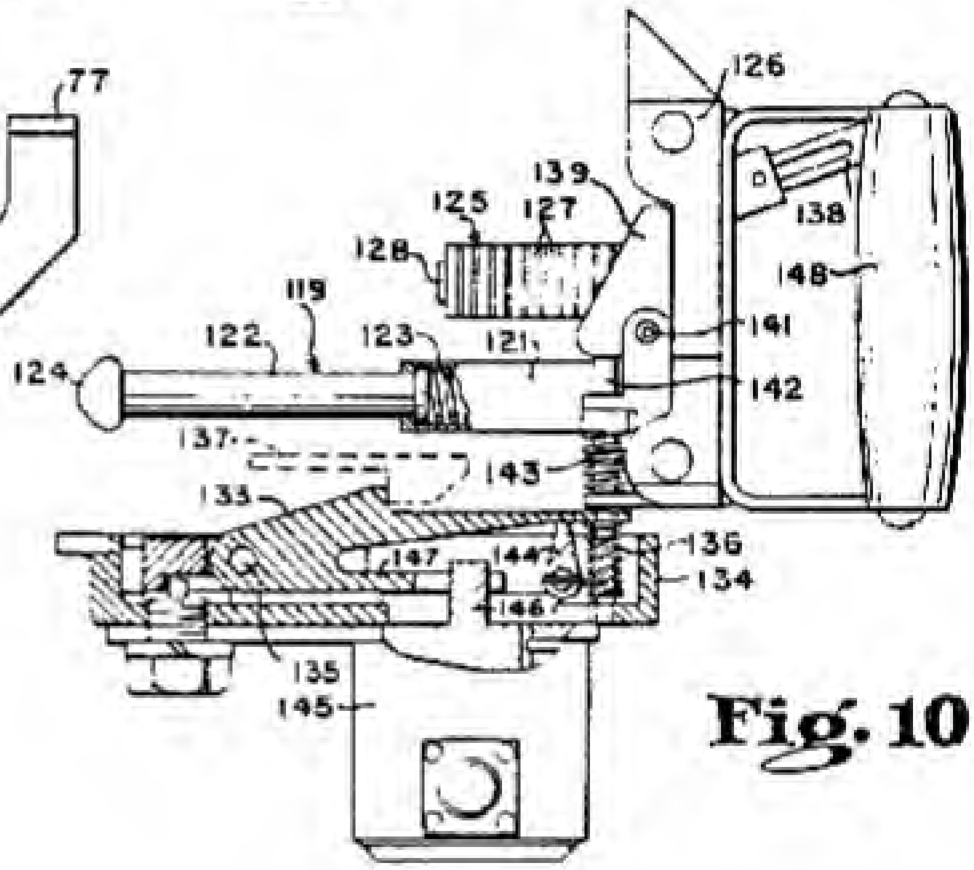
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Fig. 10.

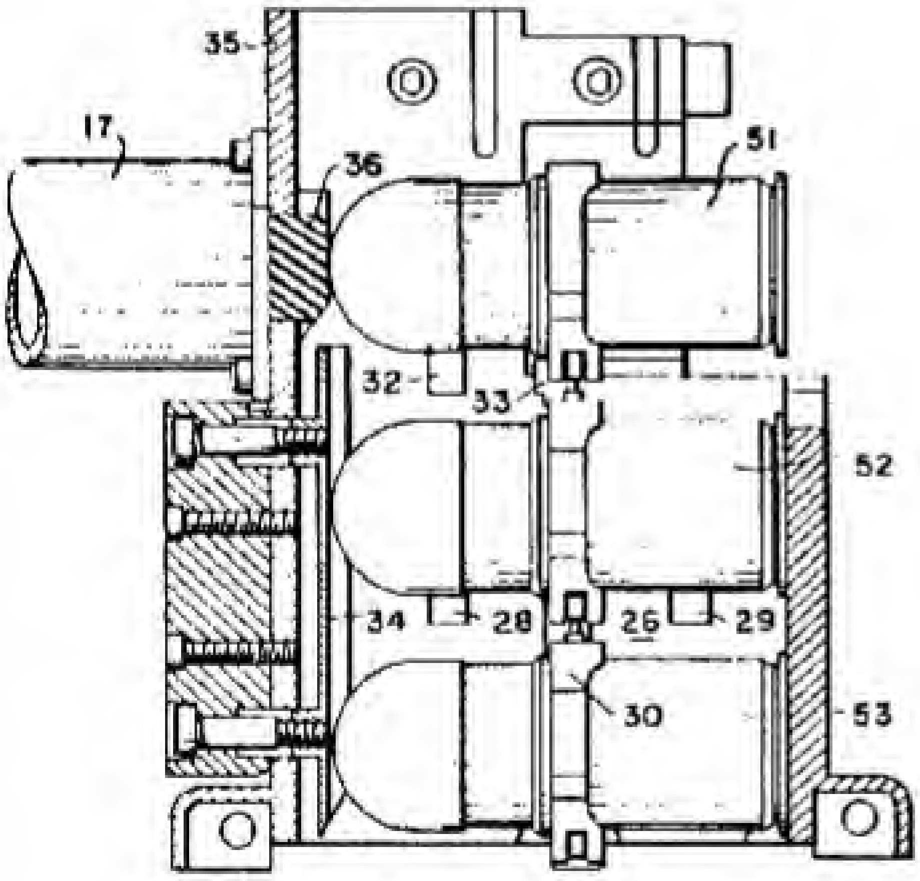
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Fig. 6.

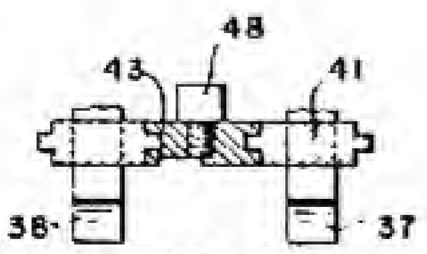
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Fig. 8.

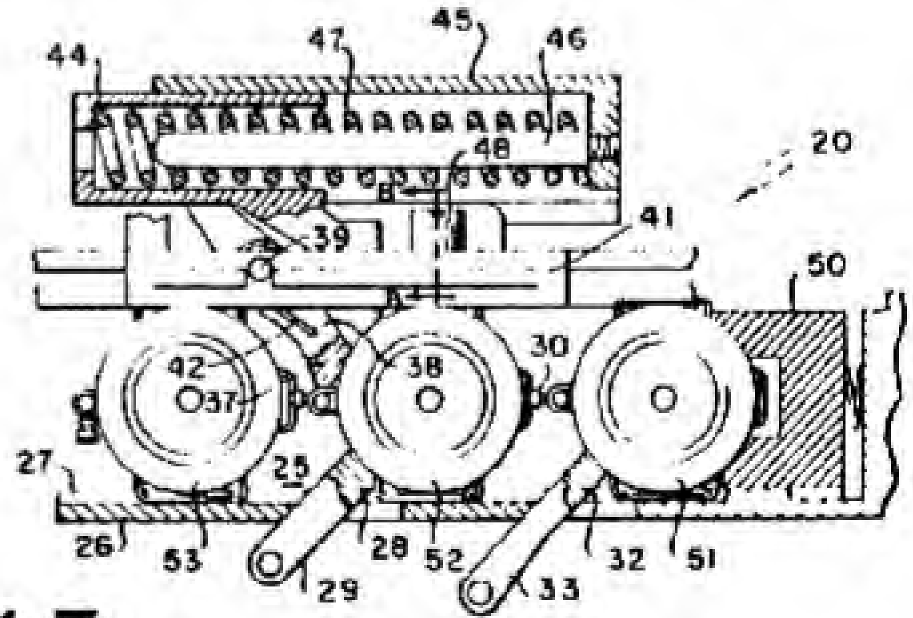
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Fig. 7.

Patent of the Mk 19 Grenade Launcher

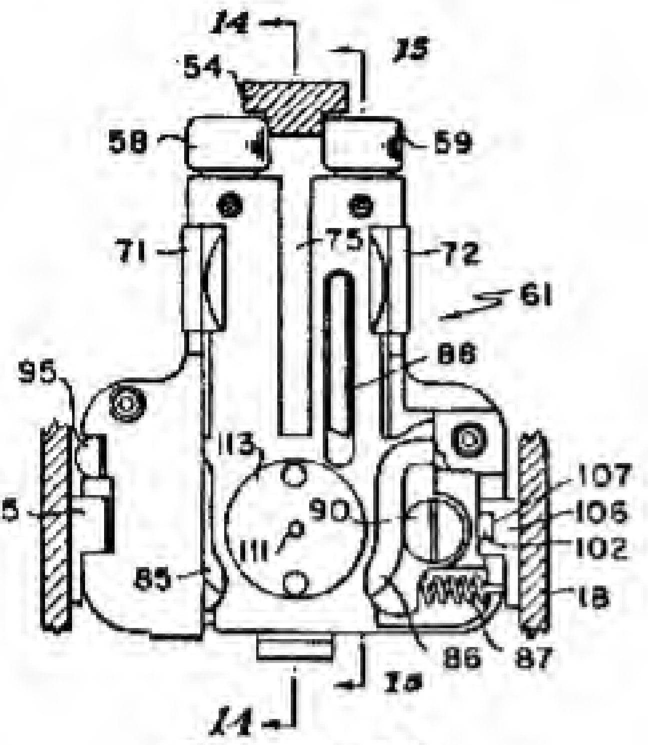
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Fig. 11.

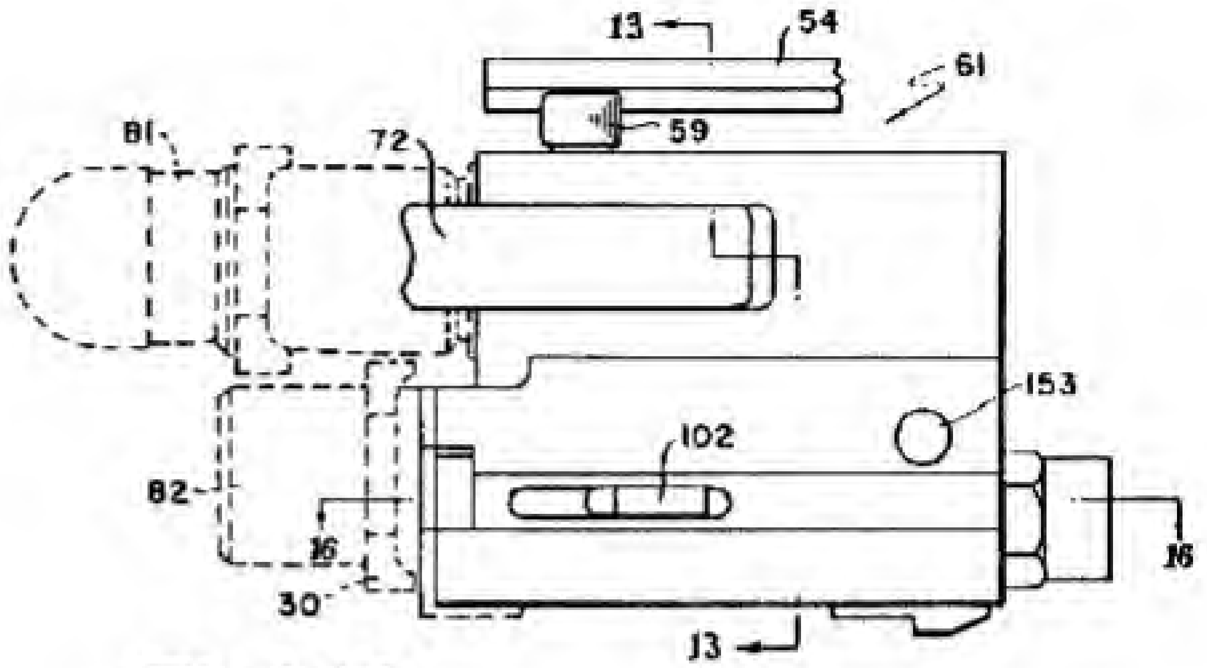
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Fig. 12.

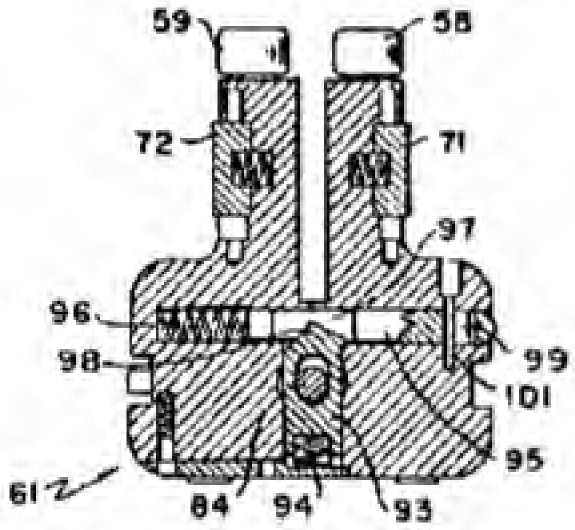
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Fig. 13.

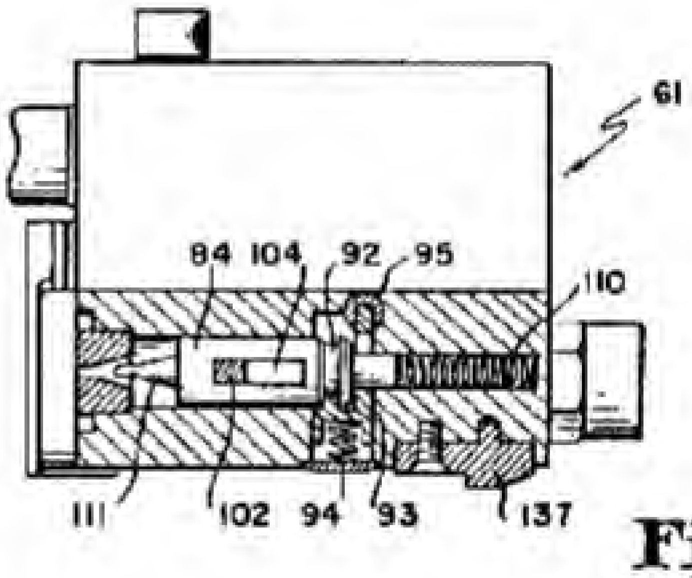
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Fig. 14.

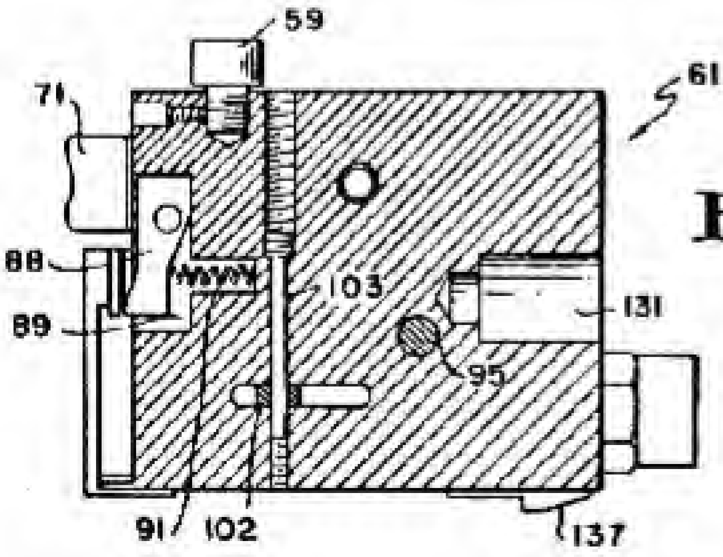
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Fig. 15.

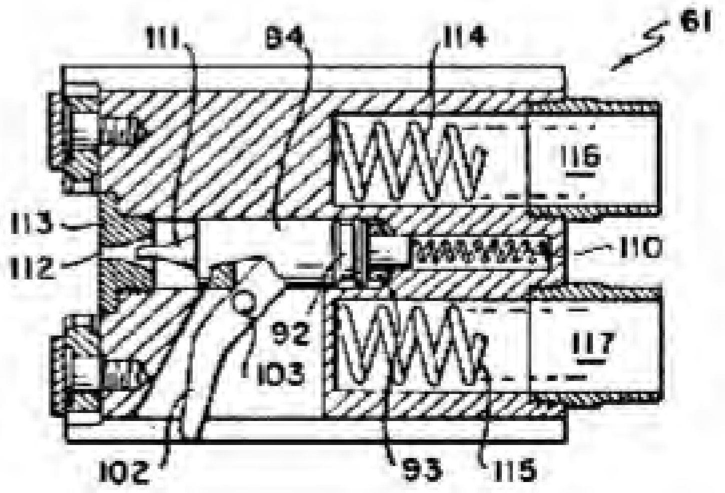
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Fig. 16.

Patent of the Mk 19 Grenade Launcher

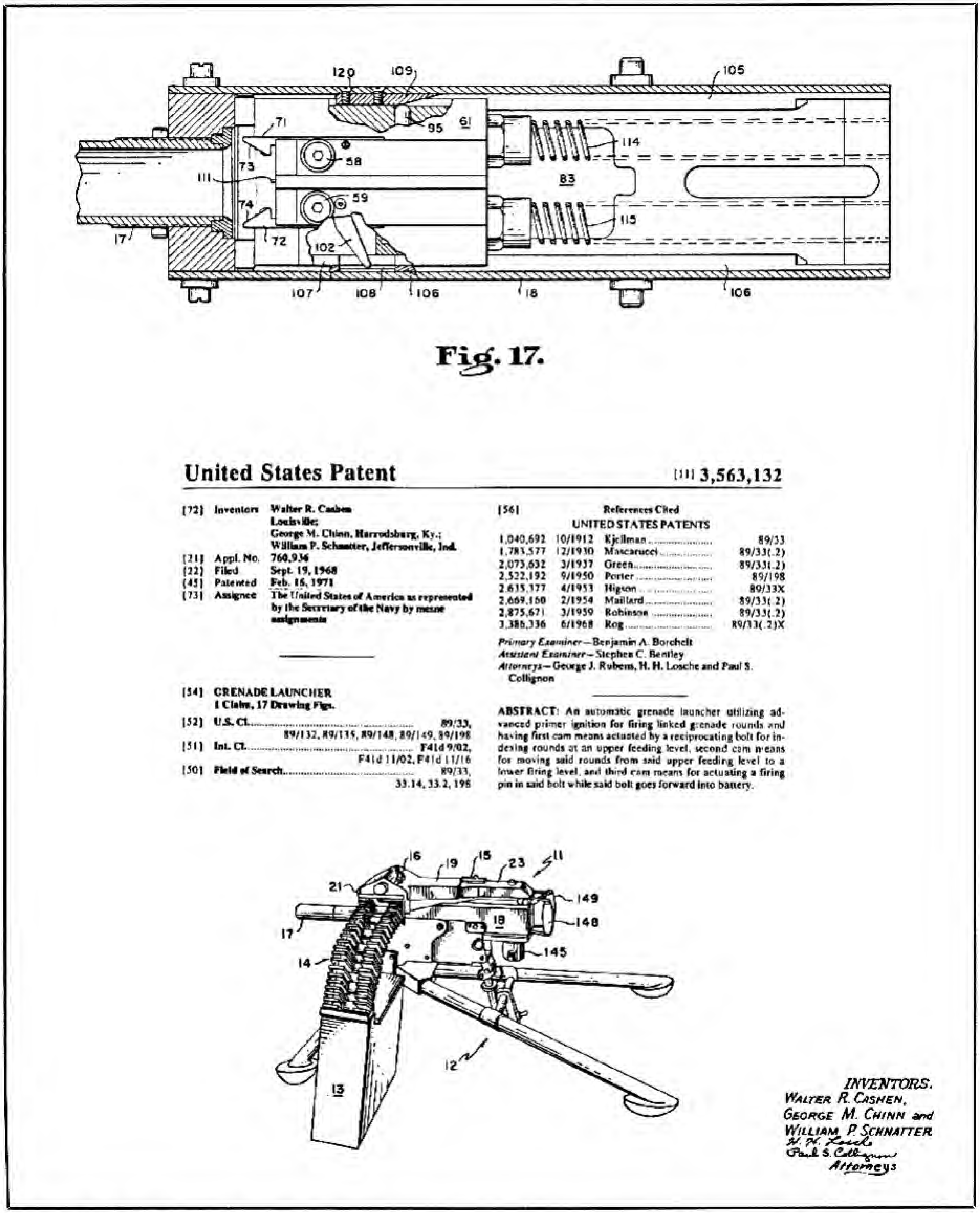
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Fig. 17.

United States Patent

[11] **3,563,132**

[72] Inventors Walter R. Cashen
Louisville;
George M. Chinn, Harrodsburg, Ky.;
William P. Schnatter, Jeffersonville, Ind.
[21] Appl. No. 760,936
[22] Filed Sept. 19, 1968
[45] Patented Feb. 16, 1971
[73] Assignee The United States of America as represented by the Secretary of the Navy by mesne assignments

[54] **GRENADE LAUNCHER**
1 Claim, 17 Drawing Figs.
[52] U.S. Cl. 89/33, 89/132, 89/135, 89/148, 89/149, 89/198
[51] Int. Cl. F41d 9/02, F41d 11/02, F41d 11/16
[50] Field of Search 89/33, 33.14, 33.2, 198

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Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—Stephen C. Bentley
Attorneys—George J. Rubens, H. H. Losche and Paul S. Collignon

ABSTRACT: An automatic grenade launcher utilizing advanced primer ignition for firing linked grenade rounds and having first cam means actuated by a reciprocating bolt for indexing rounds at an upper feeding level, second cam means for moving said rounds from said upper feeding level to a lower firing level, and third cam means for actuating a firing pin in said bolt while said bolt goes forward into battery.

INVENTORS.
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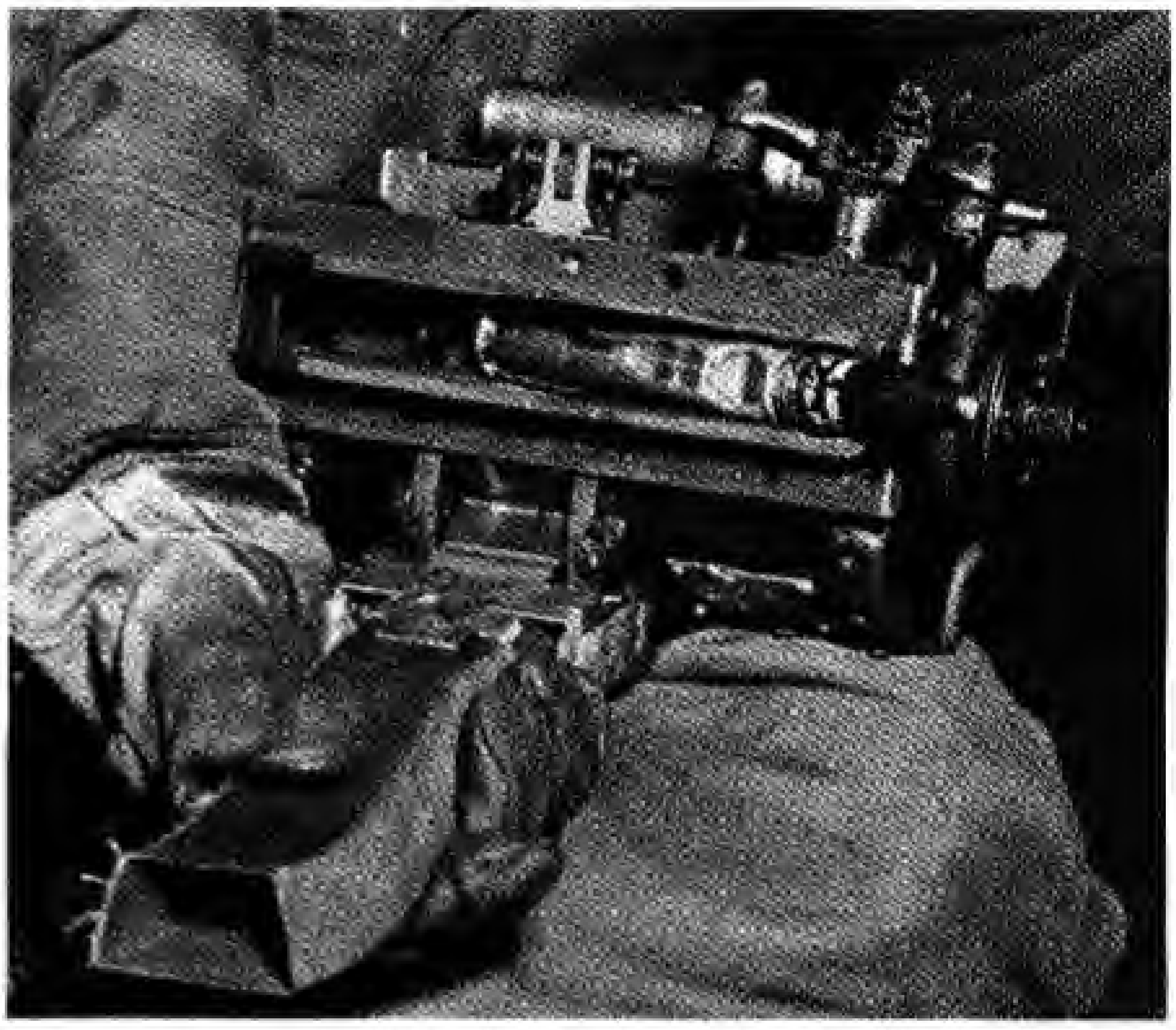
GEORGE M. CHINN and
WILLIAM P. SCHNATTER
H. H. Losche
Paul S. Collignon
Attorneys

Patent of the Mk 19 Grenade Launcher

ejection powered solely by the energy generated by the explosion of the propellant charge, something nonexistent at that time. Without the need for auxiliary power sources, this weapon could be mounted in various installations such as riverine patrol boats, helicopters, vehicles, or even on tripods for ground use.

So, in July 1966, the Naval Ordnance Systems Command, Washington, D.C., commissioned the Naval Ordnance Station (N.O.S.), Louisville, Ky., to develop, on a maximum-effort basis, two fully automatic machine gun systems. The Mk 19 was to employ the high-velocity M384 grenade while the Mk 20 would use the low-velocity M406 round.

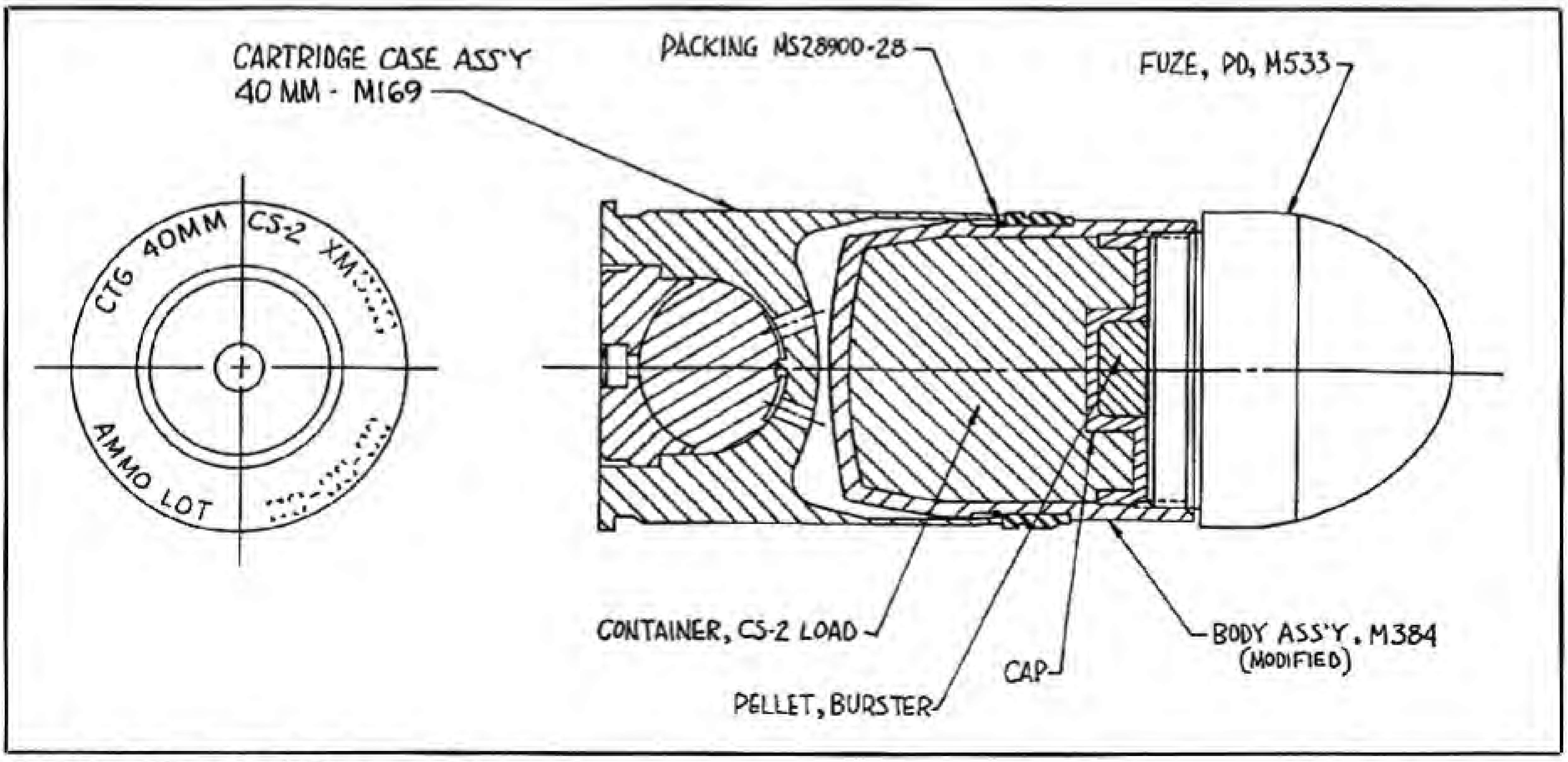
Although design and development of the Mk 19 and Mk 20 systems began about the same time and were completed within months of each other, this review focuses only on the 40mm automatic machine gun Mk 19 using the M384 grenade.


Smashed Cartridge

As an in-house facility, the Naval Ordnance Station, Louisville, had at its disposal a compilation of all phases of research and development statistics on virtually all machine gun development work as well as test reports from the Bureau of Ordnance and Bureau of Aeronautics proving grounds. These records covered the period through the first World War, World War II, and the Korean conflict.

As a first step in developing the new machine gun, designated ordnance personnel studied this information carefully and concluded that approximately 87 percent of all automatic weapon malfunctions occurred in the vicinity of the barrel's chamber as extraction failures, ejection hangups, or stubbing of the incoming round.

The Navy considered this last malfunction, that resulted in an explosive projectile being smashed against the breech of the barrel in the act of chambering, as the single most serious aircraft cannon malfunction encountered during the Korean conflict.



Cartridge, 40mm CS-2, Experimental

In the conventional Hispano-Suiza M3 20mm automatic aircraft cannon, for example, the bolt had such force on its counterrecoil stroke that it was, in effect, a powerful hammer driving an uncontrolled cartridge ahead of it. If (or when) the cartridge failed to chamber, the bolt stubbed or smashed the high-explosive projectile into the breech end of the barrel, all too often causing an explosion in the aircraft's gun compartment.

Obviously, such a situation would be a catastrophe if it occurred in a ground-mounted machine gun system using the half-pound high-explosive projectile M384 grenade cartridge.

Initially, the Navy had conducted an extensive study at the Naval Ordnance Test Station, Chincoteague Island, Va., and at odd times since 1952 had been working toward ways to eliminate this most dangerous situation. When the dangers of the stubbed round, plus the evidence of a multitude of broken extractors, ejectors, and related components, were taken into consideration, a high priority was placed on correcting these problems in any future automatic firing system or, better still, eliminating them entirely by improved design.

To alleviate the problem completely, it was necessary to design a mechanism that eliminated the parts of the gun causing the malfunctions. The simpler the design, with as few moving parts as possible, the more reliable and safe the weapon would be.

With this background and this line of thinking, it was easy to see why the originators of the Mk 19 were attracted to the curved stationary rail theory.

The curved stationary rail (also known as the vertical-cam principle) would seem an ideal approach. It not only eliminated the extractor and ejector, but also made it impossible to stub a round since the cartridge is positioned with the center line of the chamber on the recoil movement of the bolt.

To accomplish this, a graduated curve is machined on a stationary rail running through the center of the bolt with the progressive angle of the curve so situated that the incoming cartridge is cammed downward into a T-slot at the predetermined position desired on the rearward movement of the bolt.

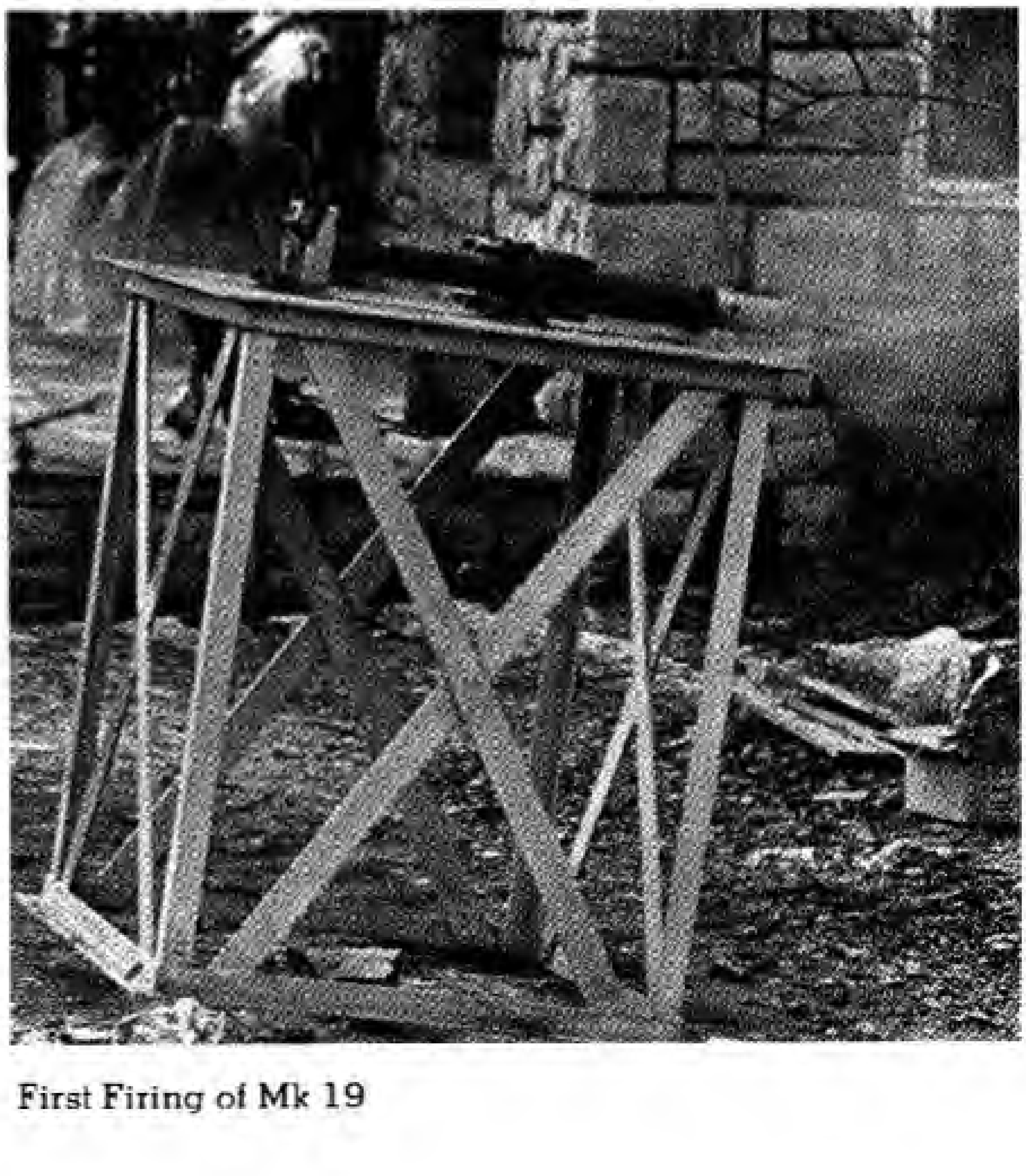
A T-slot over 0.010 inch greater than the maximum thickness of the cartridge rim is machined on the forward portion of the bolt. To place the incoming round out of the feedway onto the bolt face, a set of spring-loaded pivoting ("pickup") pawls were located at the top as a part of the bolt's T-slot. This "clothespin" arrangement snapped over the rim of the cartridge in the feedway 0.25 inch before the chambered round was fired.

The recoil movement of the bolt then placed the top of the cartridge rim in engagement with the rail's graduated curve, positioning the incoming round in the T-slot and forcing it downward until the cartridge became an integral part of the bolt with the high-explosive projectile aligned and locked on the bolt face precisely in the center line with the chamber.

Then bolt and cartridge moved forward as one unit, making stubbing impossible. Since the cartridge case remained attached to the bolt after firing, no extrator was needed—blowback forces both case and bolt rearward. As the incoming round was cammed downward into position, it kicked the empty case out of the T-slot, eliminating still another potentially, troublesome component, the ejector.

The theory of the curved rail has been around for a long time, but, as is often the case, application of the theory in its entirety has proved difficult, as the designers of the Mk 19 were to find out. For every obvious virtue, there is some hidden feature that is extremely critical. Although other weapons had been designed around certain features of the curved-rail principle, its complete incorporation heretofore had not been accomplished successfully.

Still, the designers at Naval Ordnance Station in



First Firing of Mk 19

Louisville decided to attempt application of the curved-rail principle in its entirety. With this decision made, they turned their attention to selecting as a source of power the most efficient blowback system from the four versions available: plan blowback, retarded, delayed, or advanced primer ignition.

Their choice here was helped by a characteristic of the M384 round itself. When Army technicians raised the velocity of the original M406 to create the M384, they increased the wall thickness of the rear half of the cartridge case to the point where the round could be safely fired without the last 0.75 inch of the cartridge case being enclosed by the chamber walls. In other words, the last fraction of an inch of the base end of the case could safely serve as its own firing chamber.

This feature of the M384 made advanced primer ignition possible, for it meant that the incoming round could be fired before the cartridge case was completely chambered. Advanced primer ignition would ensure the most positive means known of controlling the extremely critical timing of ignition, a problem inherent when blowback is used in any automatic weapon system. Also, advanced primer ignition had other very important advantages.

In a plain blowback system, the bolt returned all the way forward to the firing position with relatively low velocity but with considerable kinematic energy. Because the bolt was stationary when the chambered round was fired, all the explosive force of the propellant was utilized in accelerating the bolt to the rear. This action required the use of an extremely heavy bolt to keep its counterrecoil velocity within safe limits.

Substantial savings in bolt weight can be realized by utilizing the kinematic energy generated by the driving-spring-actuated, counterrecoiling, lighter weight bolt. Instead of permitting the power of the bolt to be dissipated by impact before the next round was fired, it was possible to time primer ignition so that the approaching round was fired a fraction of an inch before the bolt, at its highest velocity, reached its full forward position.

In advance primer ignition, the impulse of the explosion of the propellant must first slow and then stop the forward movement of the bolt before it can reverse its motion and be propelled to the rear. Thus, only a portion of the explosive force was used to blow back the bolt, and the time interval during which powder gases act to produce a rearward action also was reduced.

This process permitted the use of a much lighter recoiling part and produced a condition where higher bolt velocities can be translated into feeding energy when the bolt and components comprising the feed system are connected by mechanical linkage. As a result, the gun was lighter and had more available energy to pull the ammunition belt into the weapon.

Through progressive improvements the Mk 19—which took shape first on the drawing board and then as a single-shot prototype model became an experimental automatic firing device using a curved rail for feeding, extraction, and ejection, coupled with advanced primer ignition firing. From a slide-rule standpoint, all components were beautifully synchronized but still unproved for automatic fire, although mathematically sound. Naturally, it was proudly anticipated that it would function as planned.

Mathematics also seemed correctly applied when many simulated firing cycles were accomplished successfully by pulling inert rounds of ammunition through an operating cycle by hand. Finally, three linked rounds of live ammunition were placed in the feedway, and the moment of truth, represented by firing a three-round burst, was at hand.

That limited burst put the clever combination of ideas and calculations that was the Mk 19 into complete limbo. After the smoke cleared, it was sadly found that practically every critical component was either bent, warped, distorted, broken, or unusable. At this point, those involved in the origination of the weapon system felt that any enemy would be far safer in front of the weapon than they would be behind it.

The cliche for such a situation is, "Well, back to the old drawing board." But in this case the drawing board had been tried and found not to be the answer. So those in authority adopted another approach, sometimes called the "cut and try" method.

In its rather elementary, but highly accepted procedure, widely used by those who engage in automatic weapon experimentation and development, each critical part of the Mk 19 which failed, and at this stage that meant practically all of them, was "overenergized" until the offending component would stand a complete firing cycle.

After the parts had been so strengthened that they would complete at least one cycle of operation, those components still showing excessive wear in the form of gall spots, mutilation, or undue friction marks were relieved in the field with a file (hence the name, "cut and try"), followed by a drawing change to conform. Now, instead of working from a blueprint, the designers were working toward one. Every modification was subjected to continuous firing, filing, refitting, blueprint correction, and firing again and again.

Although by this point limited burst firing was attained, the over-all operation of the Mk 19 was still far from acceptable: the designers realized that in order to retain the curved-rail theory in its entirety with all its unbelievably good features, certain peculiar and unpredictable malfunctions had to be corrected soon.

They had begun with research into past failures and successes. Through 100 percent cooperation of the U.S. Marine Corps Museum at Quantico, Va.; where throughout the years the director had the foresight to acquire the actual hardware representing the world's effort, in automatic firing mechanisms, the Louisville Ordnance Station had access to virtually all previous machine gun systems.

There is no way to overemphasize the value of the material furnished for study by the Marine Corps Museum. Some features lifted from a manufacturer's drawings of certain weapons needed only modification by scaling up to be adaptable to the mechanism of the concept that resulted in the Mk 19. Other components furnished clues about how to overcome persistent malfunctions that still plagued the weapon.

Because of this assistance, along with suggestions from Army Ordnance engineers of Springfield Armory and Rock Island Arsenal, three functional machine shop versions existed on January 29, 1967, just 7 months and 22 days from the first line drawn on the drafting board. All three versions could be fired in extended bursts in both full and semi-automatic mode.

From the thousands of rounds of continuous firing on these engineering prototypes, it became obvious that the curved-rail principle, as originally desired, could be made functional. But many beneficial design improvements continued to be made during the testing of the earliest models.

By October 12, 1967, manufactured versions of these three greatly improved Mk 19's, with an average of over 30,000 rounds fired on their major components, were ready for all phases of official field and proving-ground testing. Sixteen months had elapsed since the introduction of the theoretical Mk 19 to the actual production model.

The Mk 19 Mod 1, as it was officially known, was first introduced in Vietnam in January 1968, when it was placed on the Navy's river patrol boats and Huey helicopters operating from Dong Tam. In March, the first compilation of field reports indicated that the weapons were operating satisfactorily and were outstanding for delivering suppressive fire, thereby bringing snipeing to a definite halt.

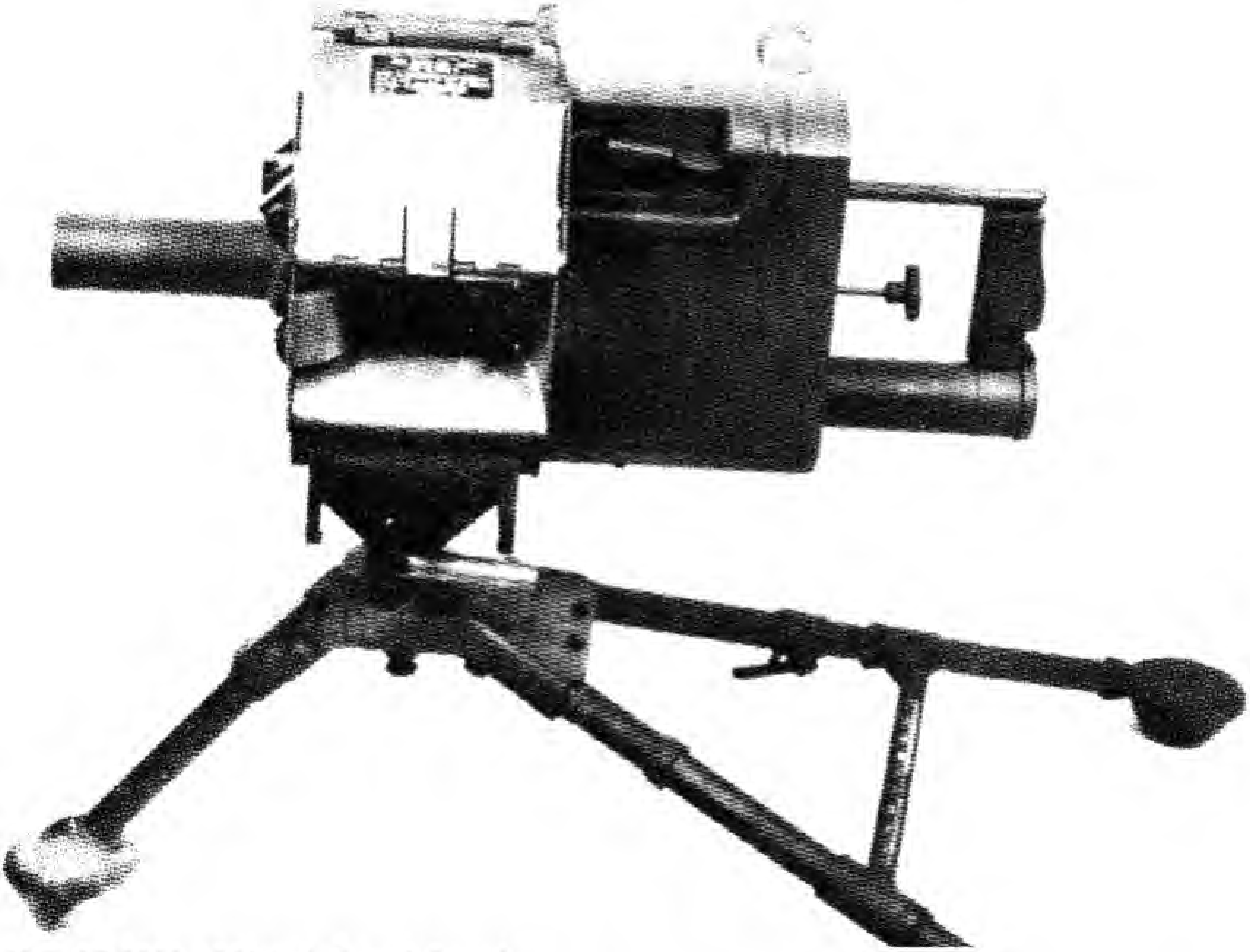
As it finally evolved, the Mk 19 Mod 1 is a finished weapon weighing less than 50 pounds and is capable of placing, in one minute, 300 pounds of high explosive projectiles on a target at a range in excess of 1½ miles. Its ability to neutralize an area with its overwhelming firepower needs no elaboration.

In addition to its effectiveness as a combat weapon, the Mk 19 Mod 1 is also significant from a design standpoint. The curved rail, that "siren's song" of automatic weapons designers, found its way from theory into full incorporation in an actual weapon.

Chapter 58

40mm Mk 18 Mod 0 MULTIPLE GRENADE LAUNCHER

HONEYWELL CORPORATION

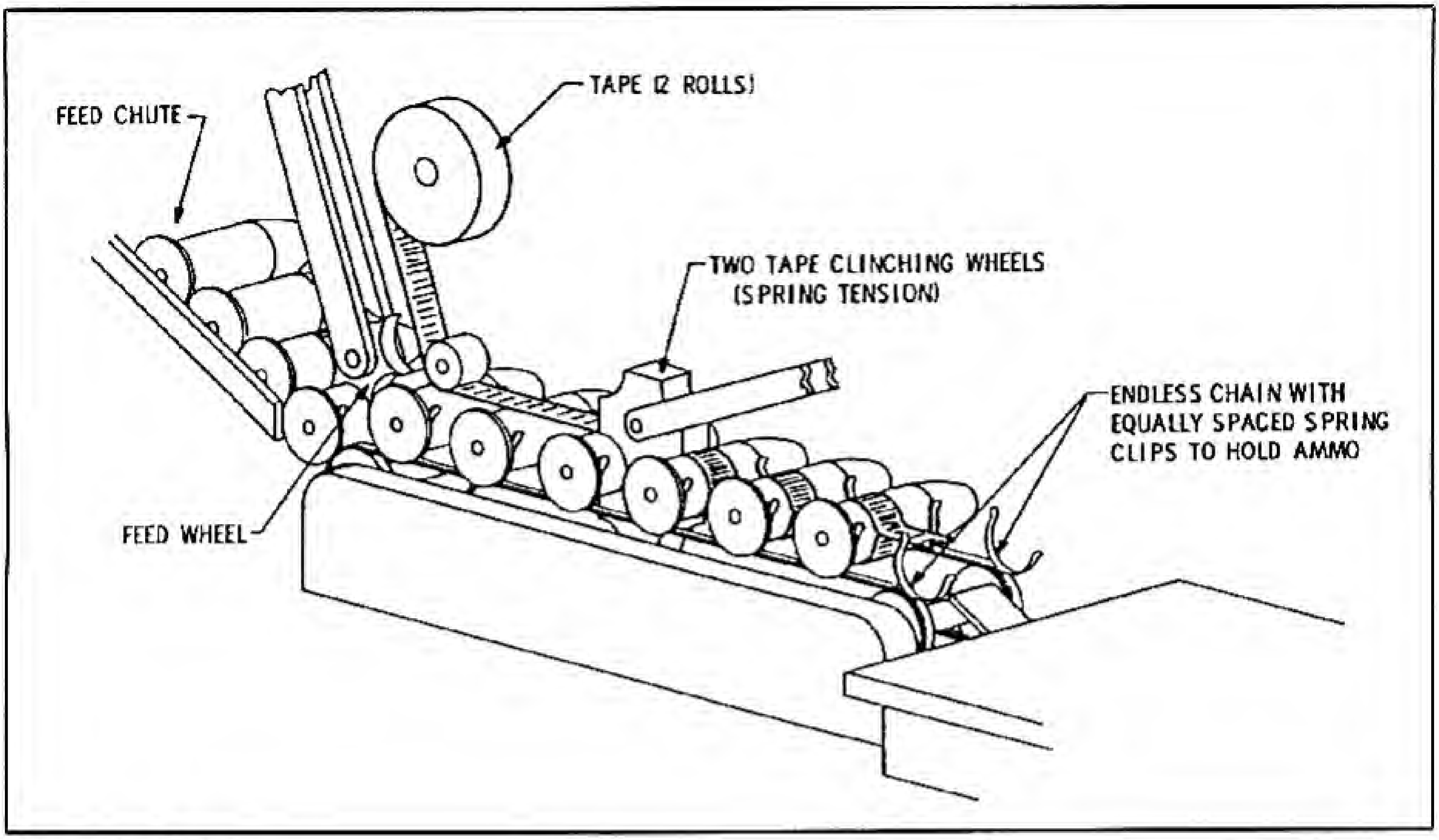


40mm Mk 18 Mod 0 Multiple Grenade Launcher

History

This weapon, MK 18 Mod 0, represents the introduction in 1962 of a new concept in weaponry, that of a rapid fire grenade launcher. It is the first step past the single-shot M79 grenade launcher.

The 40mm Mk 18 utilizes a split breech concept which has been previously used but has some original characteristics based on the introduction of a mecha-



Ammunition Belting

nism to allow the top rotor to move vertically and synchronizes the bottom rotor.

Between 1965 and 1968, approximately 1200 of the Mk 18 Mod 0, 40mm Multiple Grenade Launchers were produced by the Honeywell Corporation and Aeronautical Products Division, Hopkins, Minnesota.

The first patent application was filed by Honeywell in 1964, however, the initial development work commenced in late 1962. The concept was originally proposed during a study on the behavior of fuzes for the M79 grenade launcher ammunition.

Honeywell had anticipated the need for a simple, inexpensive and extremely mobile rapid fire weapon that could provide a team of two men with an effective capability for delivering large quantities of explosive grenades within a limited range primarily for suppressive and defensive fire purposes. The development of the 40mm cartridge grenade with its two stage propelling system (essentially an impulse system) made such a weapon possible. The high-low pressure propelling system utilized in the 40mm cartridges permits the use of a split breech mechanism which allows the weapon to be extremely light and simple.

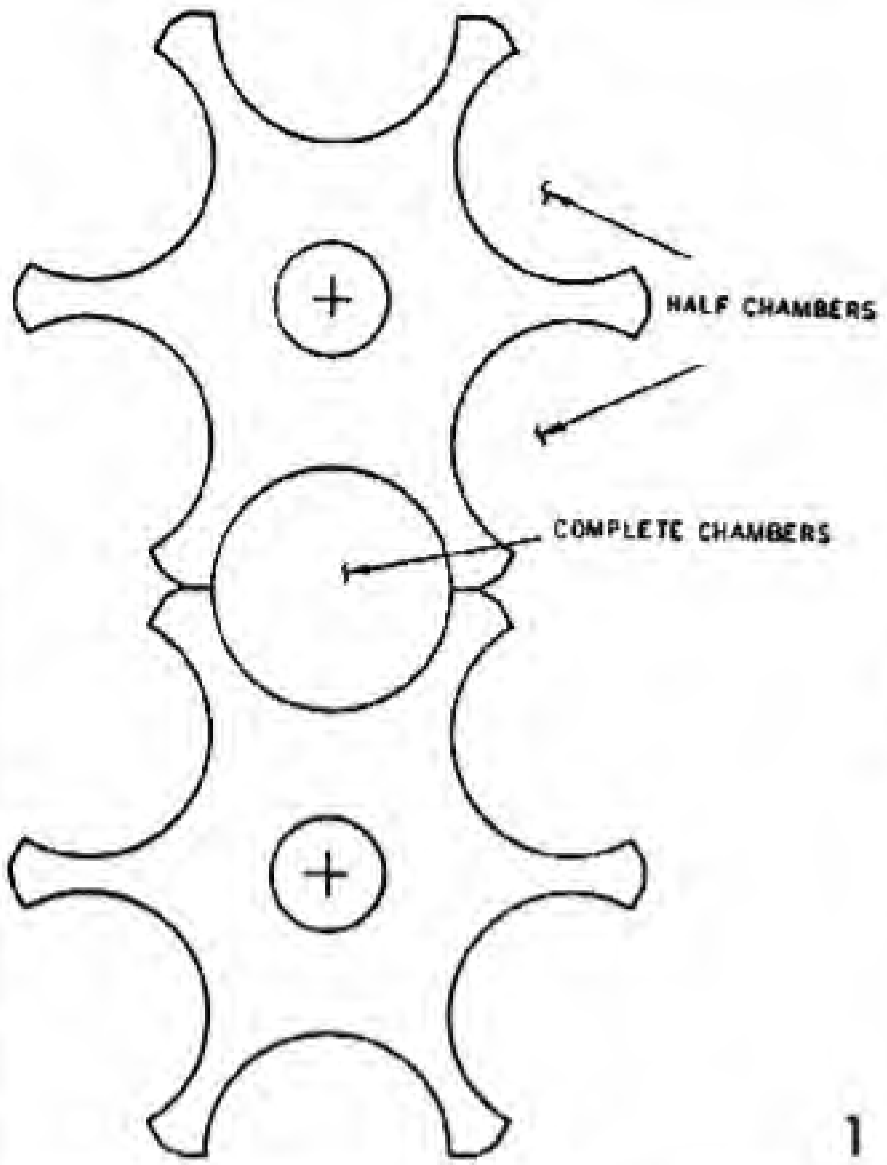
Description

This gun is a manually operated (hand cranked), belt fed, rapid fire, 40mm weapon designed to provide coverage of targets with high explosive fragmenting grenades. It will fire at variable rates up to 250 rounds per minute at ranges from approximately 328 yards up to 2,200 yards.

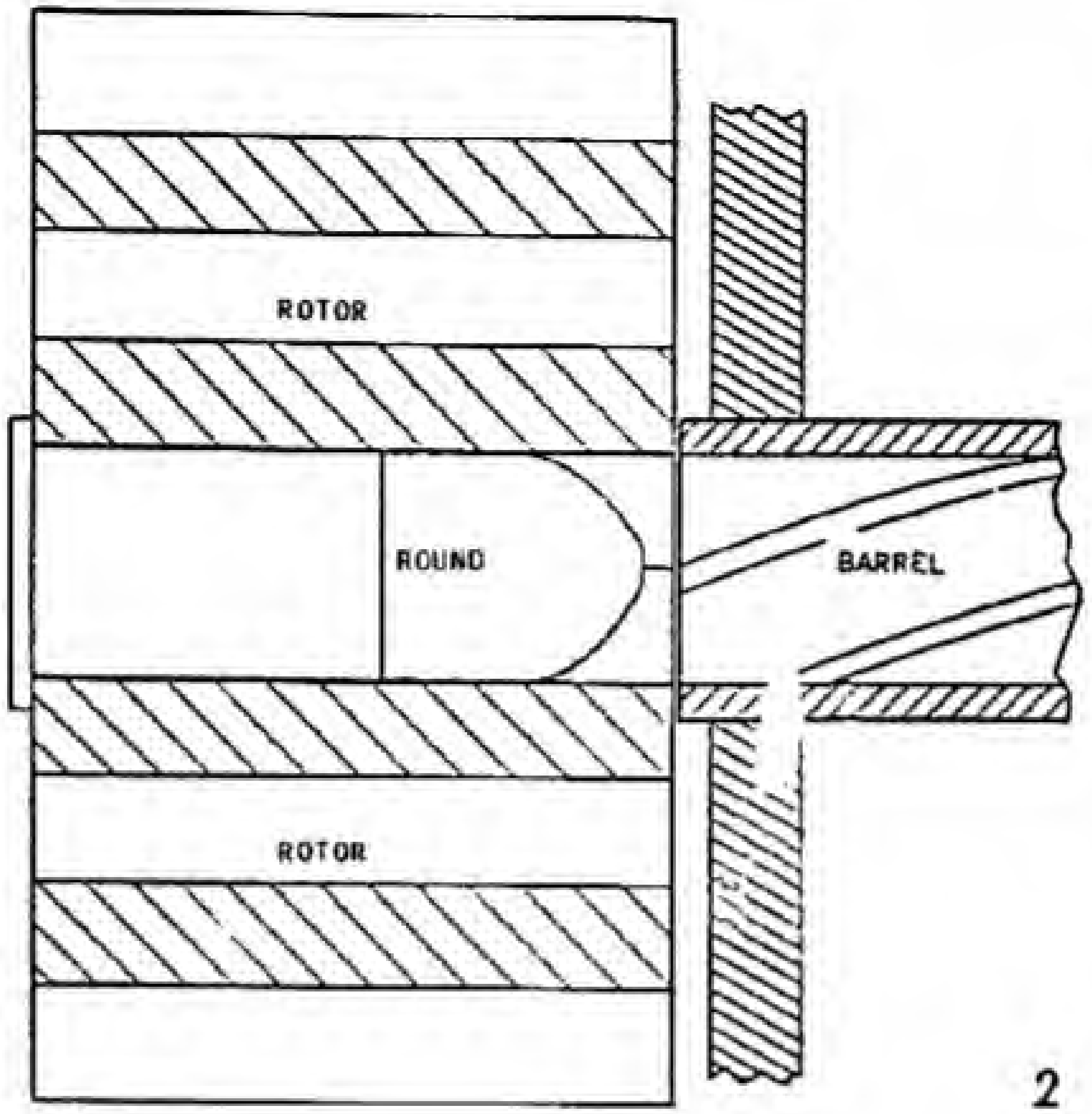
The rotary split breech, utilized in this weapon, allows straight through feeding of ammunition and eliminates the need for a reciprocating bolt, extraction of ammunition from a belt, extraction from a chamber and ejection from the weapon. This split breech weapon will fire all of the cartridges intended for use in the M79 launcher.

The ammunition is belted in a fabric (fiberglass tape) at the correct intervals, the empty cartridge remain in the belt as they are fired. The firing rate may be continuously varied from 1 to 250 rounds per minute in hand crank operation, governed only by the operator. If higher firing rates were desired, this could be achieved by motorizing the drive mechanism.

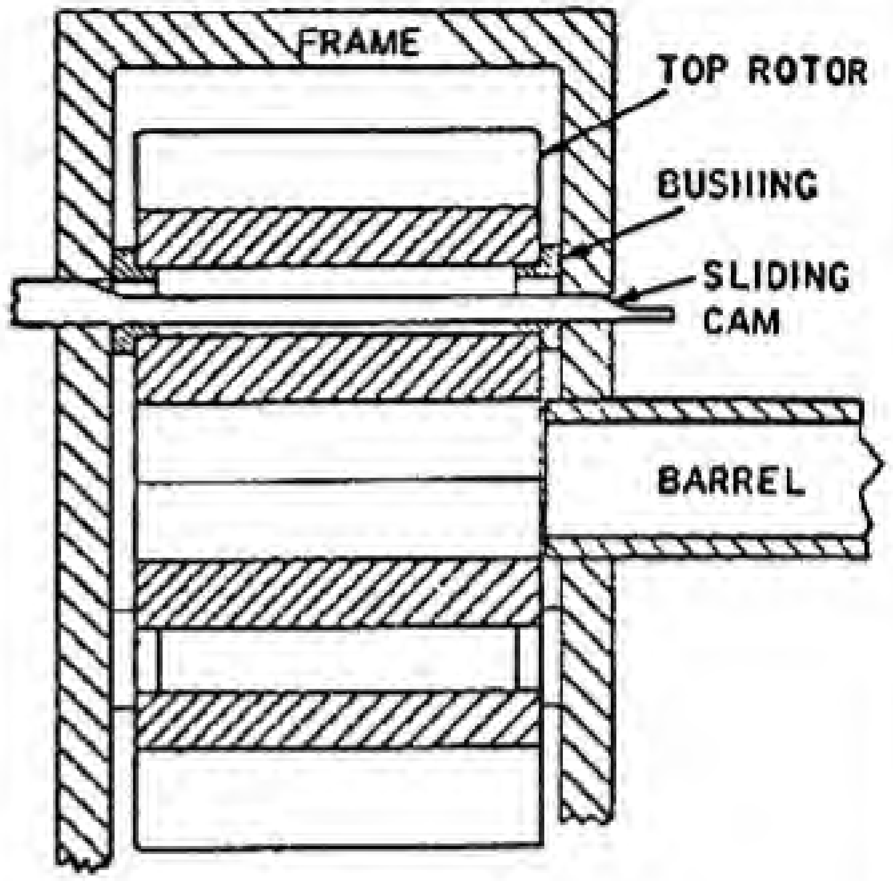
The Honeywell Multiple Grenade Launcher consists of the following parts:


HALF CHAMBERS
COMPLETE CHAMBERS

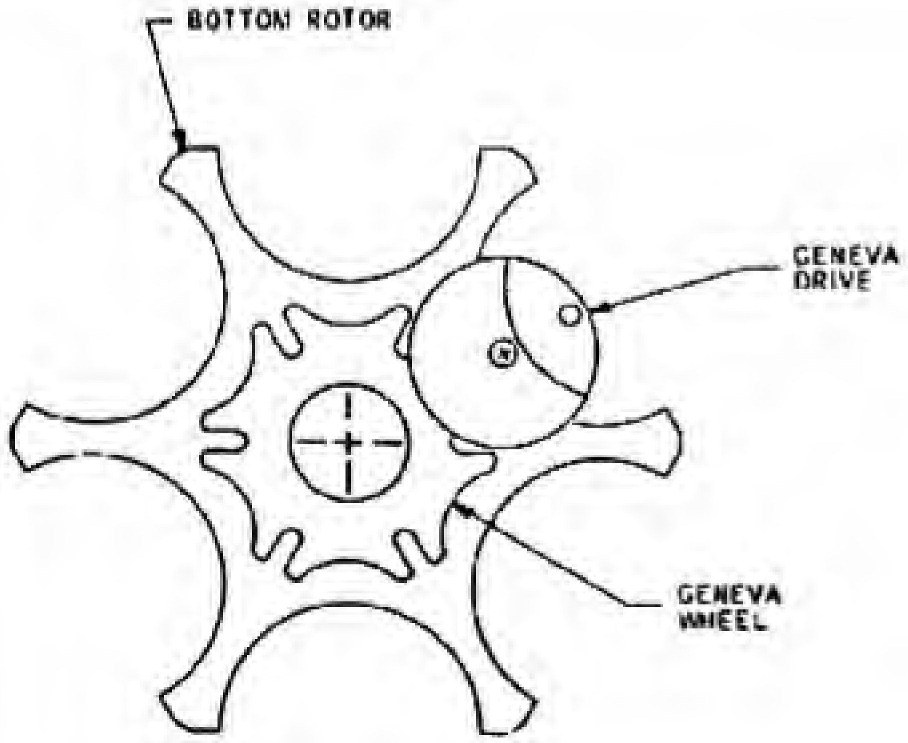
1


ROTOR
ROUND
BARREL
ROTOR

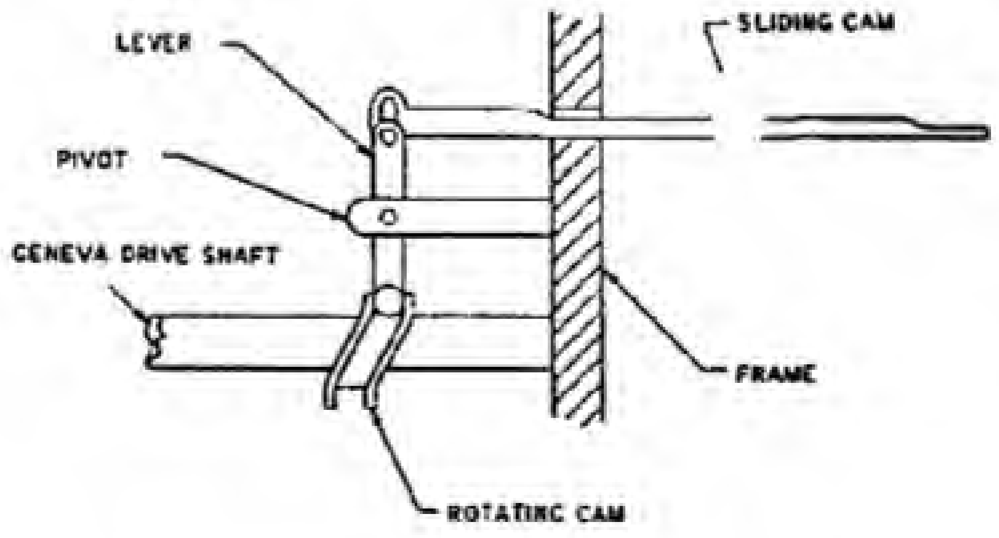
2


FRAME
TOP ROTOR
BUSHING
SLIDING CAM
BARREL

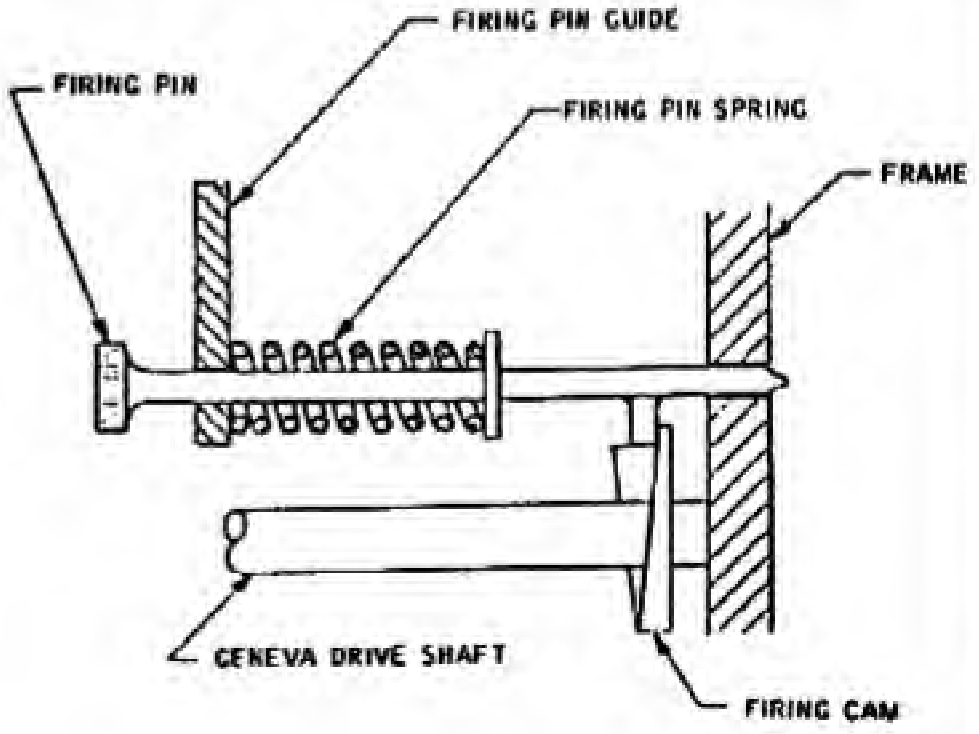
3


BOTTOM ROTOR
GENEVA DRIVE
GENEVA WHEEL

4


LEVER
SLIDING CAM
PIVOT
GENEVA DRIVE SHAFT
FRAME
ROTATING CAM

5


FIRING PIN GUIDE
FIRING PIN
FIRING PIN SPRING
FRAME
GENEVA DRIVE SHAFT
FIRING CAM

6

—rotors
—sliding cam
—six position geneva wheel
—lever and cam
—firing mechanism
—drive mechanism
—housing

The split breech concept was developed in the form of two rotors, each containing six half-chambers equally spaced about their circumference (1). These rotors are positioned such that they form six complete chambers as they are rotated. The complete cartridge is contained in these rotors and is fired through a barrel aligned with the complete chamber. The chamber is separated from the rotors by a small gap in the manner of a cylinder and barrel on a revolver.

It was evident that the rotors (1) were unable to rotate past their firing position if one or the other of the rotors is not on a movable hub. As a result, a mechanism was introduced into the hub of the top rotor which allows it to rise vertically when the two rotors are turned out of the aligned position. This mechanism (3) consists of a sliding cam riding in slots in the frame of weapon.

The wheel with its intermittent motion is then used to drive the bottom rotor (4). This mechanism also provides positive alignment between the chamber and the barrel. It permits a dwell time, while the chamber is aligned, to allow the firing mechanism to be easily synchronized.

It was also necessary to couple the sliding cam which positions the top rotor to the drive shaft so that the top rotor would be locked down during a firing sequence and be free to rotate between firings. This was accomplished through the use of a lever and cam arrangement (5). The cam was fastened to the drive shaft and the lever pivot fastened to the frame.

Characteristics

Calibre	40mm
Weight	19 lbs.
Length	22 in.
Width	9½ in. without crank 13½ in. with crank
Height	12 in. breech closed 17 in. breech open
Mode of Fire	Hand cranked
Direction of Feed	Left hand
Type of Feed	Mechanical (belt)
Rate of Fire	0-250 rounds per minute
Maximum Range	4,593 yds.
Effective Range	3,937 yds.
Muzzle Velocity	215 feet per second
Barrel Twist	Right hand, one turn in 48 in.
Barrel Length	6 in.
Cooling	Air

The firing mechanism developed uses a spring loaded firing pin and a circular cam which compresses the firing pin spring during the rotor turning time and drops the firing pin during the dwell time. The dwell time permits relatively loose synchronization between the rotor turning mechanism and the firing cam (6).

The drive mechanism for the weapon consists of a manual crank. This method of driving was chosen because it provides close control of the firing rate, it is simple, inexpensive and reliable. Because the drive shaft runs parallel to the axis of the weapon, a set of bevel gears were introduced to allow the crank shaft to be turned 90° to the drive shaft thus producing a more convenient crank position for the gunner. In addition, a ratio of 2:1 was introduced through the bevel gears to allow a greater firing rate at a more convenient cranking speed.

The complete weapon includes a housing which encloses the drive cam and firing mechanism, a grip mounted on this housing, an ammunition chute, a carrying handle, and a pintle for mounting. The weapon may be mounted on a tripod, a ring mount, or a pedestal. A tripod mounting will be assumed for the purposes of this discussion.

Ammunition Belting. For general purpose use, the ammunition is contained in 25-round belts. The ammunition is belted in the manner illustrated here. A feed wheel counts 25 rounds, then stops feeding—the spring clip chain continues, carrying the rounds, properly spaced, between the two strips of tape. The tape strips, adhered together, secure the rounds at their proper intervals. A heavy leader strip and stop strip are attached to the belts, finishing the operation. This operation can easily belt 500 rounds per hour.

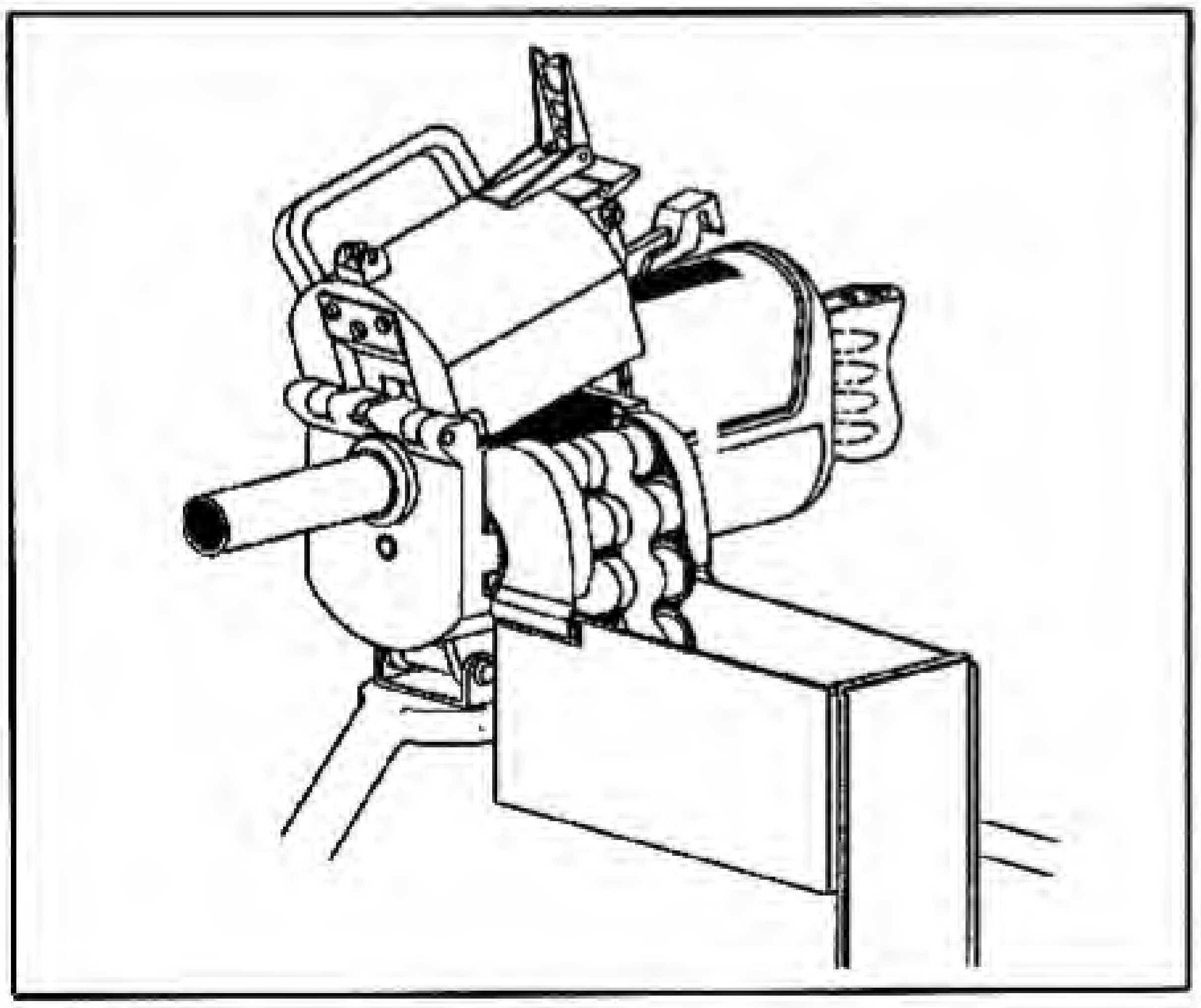
Cycle of Operation

The weapon can be mounted on a tripod and ammunition box attached. The firing pin is retracted and turned to the SAFE detent. The ammunition box is opened. Both dust covers on the weapon are opened. The crank is turned to a position such that the top rotor is free to be raised. The tab of the ammunition belt is slipped between the two rotors so that the tab extends through the weapon from left to right. The top rotor is turned to the "LOAD" position and the crank is turned to the detent in the "LOAD" position. The tab is then pulled as far as possible to the right and maintained. The crank is turned clockwise ½ turn to allow the rotors to collect the round, locating it into the formed chamber. The firing pin is retracted and turned to the "FIRE" position. The weapon is now ready to fire.

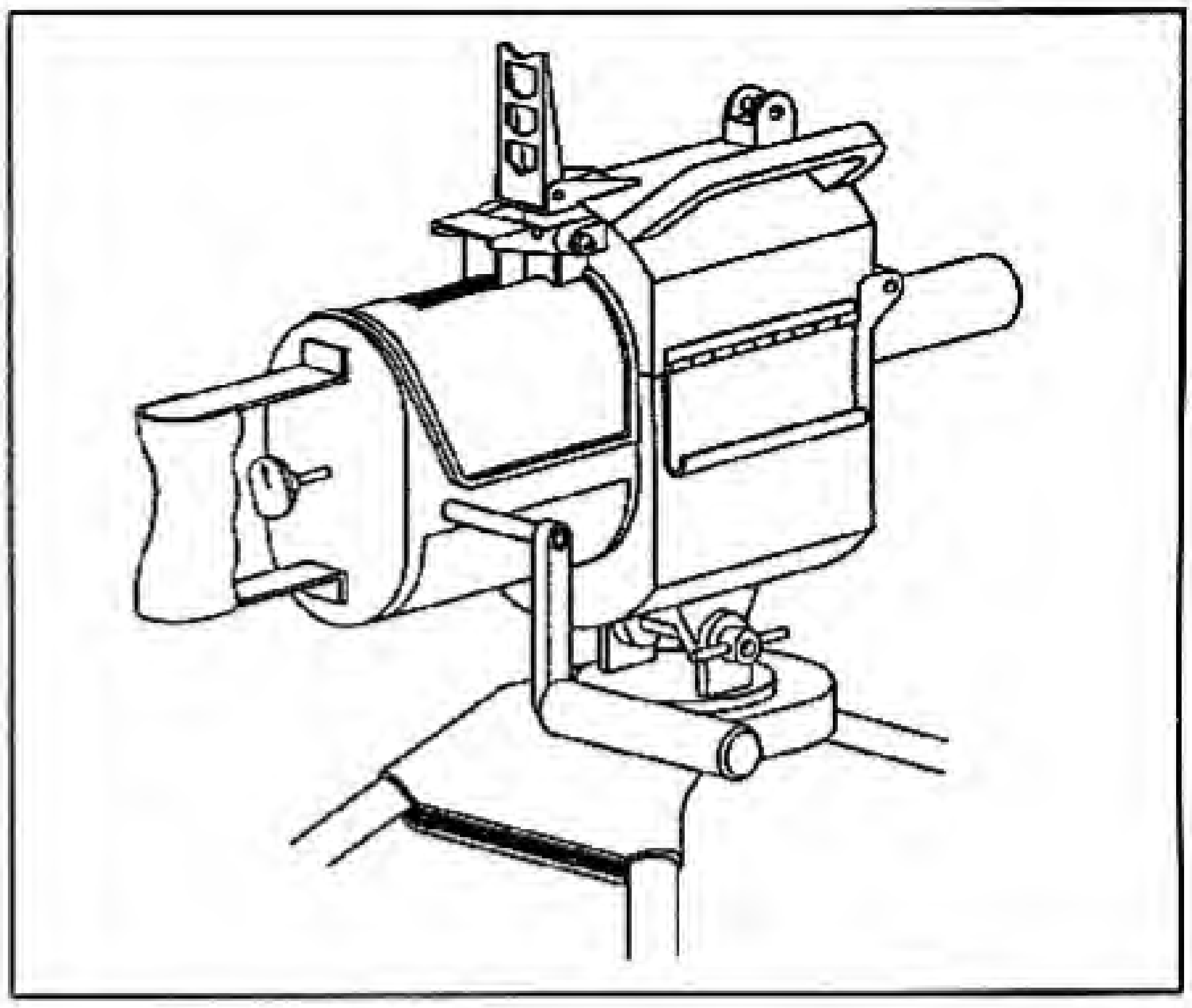
The first round will fire when the crank has been turned clockwise approximately 30°. The weapon will continue to fire one round for each half revoltuion of the crank until the supply of ammunition is exhausted. The firing rate is continuously variable and dependent only on the operator. Single rounds may be fired easily by merely rotating the crank one half revolution from detent to detent. Firing rates as high as 250 rounds per minute may be achieved. To reload the weapon, merely replace the empty ammunition container with a full one and repeat the operations as described.

Weapon Modifications

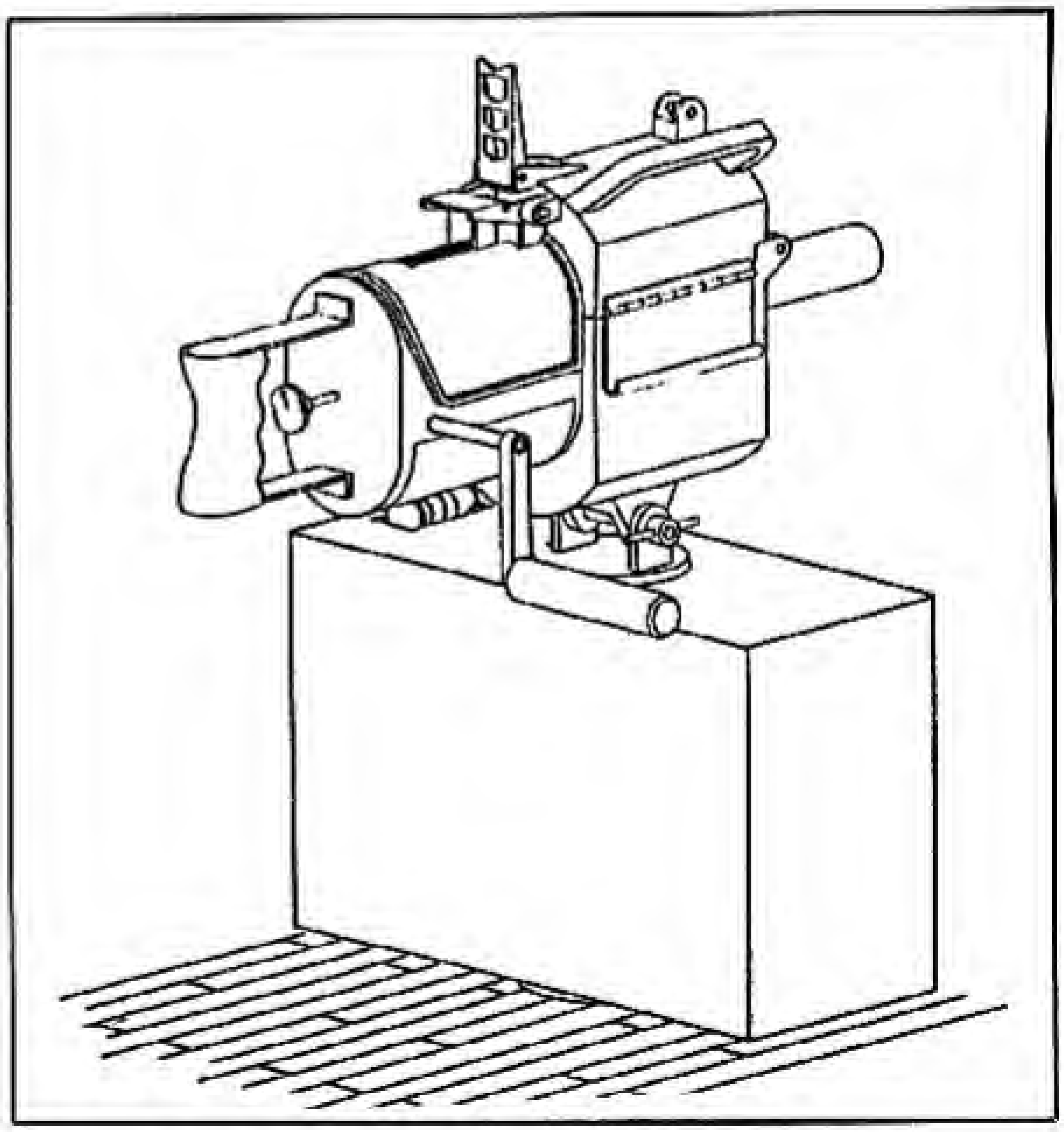
The purpose of this section is to present possible modifications that were once considered to Honeywell for incorporation into the Multiple Grenade Launcher. These modifications are presented as four artist concepts.



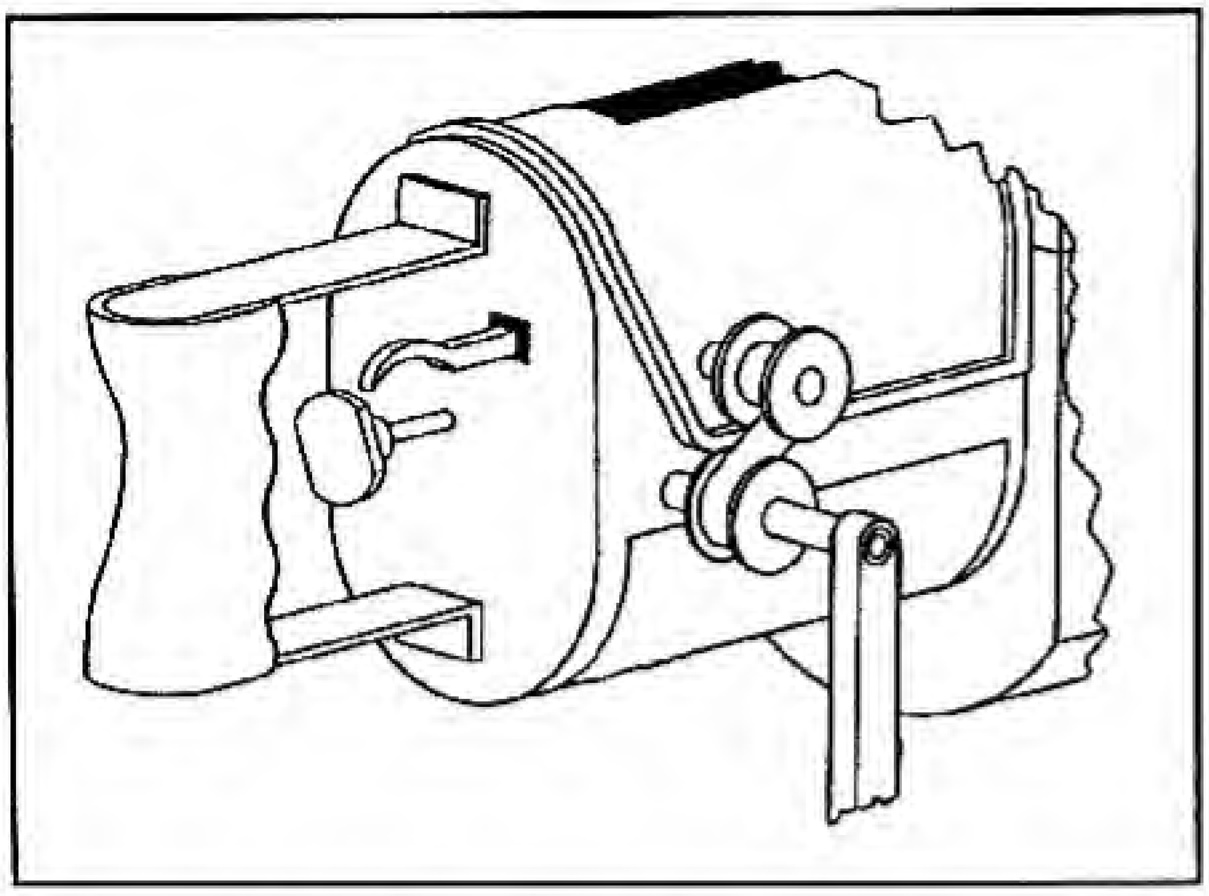
Concept 1 illustrates a break-open breech. This will facilitate more rapid loading. The top rotor with the locking cam opens forward to receive the new belt of ammunition. As the breech is opened the mechanism is locked in position so as not to disturb the firing sequence in any way.



Concept 2 features the rear right view of the weapon. Particular notice is given to the breech lock and release mechanism. The spent cartridge cases remain in the belt as they are discharged through the opening in the right side of the rotor housing.



Concept 3 shows the gun mounted on the deck of a small boat or river craft. The modified ammunition box becomes an integral part of the mount. Because the boat can carry an unlimited supply of ammunition, the magazine can contain 100-200 rds. each.



Concept 4 depicts a spring drive mounted inside the gun as a portable power drive. The constant torque spring is wound with the hand crank; the crank is disengaged; the trigger mechanism then fires the rounds. For the next belt of ammunition, the spring can be rewound. If for any reason, the gunner is unable to wind the spring, he can reverse the cranking mechanism and fire the gun manually. If desired this mechanism can also be power driven by means of electric motor.

Ammunition

The gun is capable of firing the following 40mm rounds:

M406 Projectile, 40mm, High Explosive
M407 Projectile, 40mm, Practice, Smoke
M387 Projectile, 40mm, Practice, Inert

The High Velocity 40mm M384 cannot be used in this weapon.

Test Results

From results of the evaluation it was concluded that the prototype 40mm Mk 18 Mod 0 grenade launcher as received from Honeywell Inc. will fire 5000 rounds without wearout failures. However, during the evaluation, the performance of the gun, especially during the first 3000 rounds was unsatisfactory because of the high stoppage rate due to faulty ammunition belting, inadequate firing pin protrusion, and the rough cycling action of the weapon at the higher rates of fire.

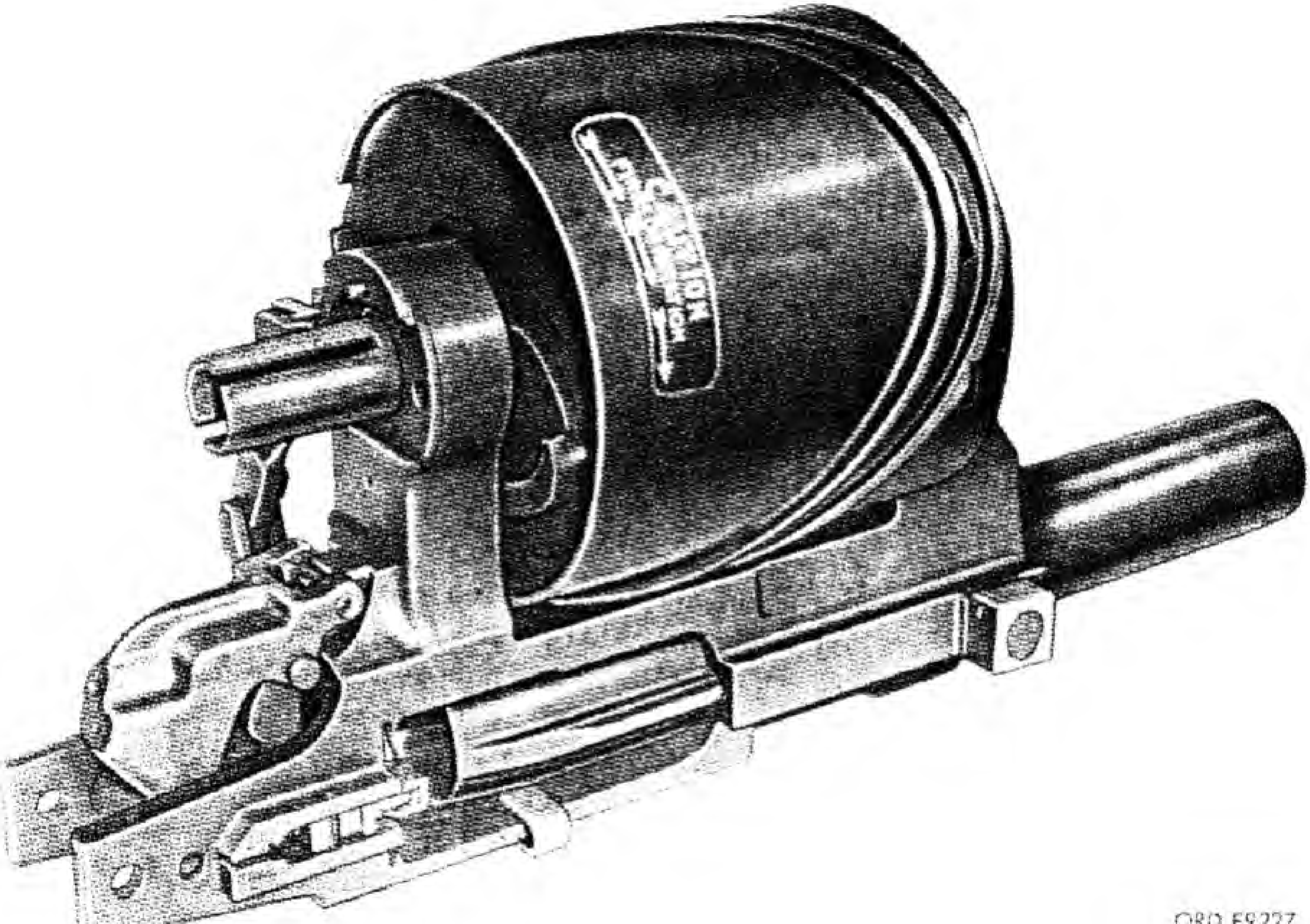
It was also recommended that the firing mechanism be modified to prevent inadvertent firing of the round during movement of the firing pin from the safe to fire position.

While this concept was soon declared obsolete due to the introduction of the much needed automatic 40mm grenade launcher system, Honeywell's contribution to the state of the art was outstanding.

Chapter 59

40mm M75 GRENADE LAUNCHER

PHILCO-FORD CORPORATION



ORD F9227

40mm M75 Automatic Grenade Launcher

History

The first patents that resulted in the M75 were applied for in 1961 and in that year the development and production of the M75 gun and the its special link was begun by Philco-Ford. The work continued until 1967 and resulted in the production of 500 guns.

As part of the program for Army Aircraft Armament, the 40mm grenade launcher subsystem, designated M5, was developed for UH-1 series helicopter to provide fire suppression, self-protection, and short-duration air-to-ground fire support.

Two rounds of ammunition were developed for the launcher, the M384 high-explosive cartridge and the M385 practice cartridge. Their designs were based, respectively, on the high-explosive and practice 40mm grenades for the M79 shoulder fired launcher. The cartridges have velocities of about 850 feet per second, considerably higher than the original design. These new rounds were accurate to a range of 2,405 yards. The M533 point-detonating fuze was employed in the XM384 and XM385 projectiles.

The fuze was developed to operate under much higher setback forces than could be withstood by the original fuze used in the M79 40mm shoulder fired grenade launcher. This results from the fact that XM75 grenade launcher had considerably greater chamber pressure than the M79. Because the M75 weapon was fired from a helicopter, the projectiles with the later fuze was designed to hit nose first. Though constructed to function primarily by nose impact, the fuze also functions on graze impact. For safety in firing, it had a delayed-arming distance of about 60-120 feet from the muzzle of the launcher. Both types were detonator safe, and would not become armed until they were acted on by both setback and centrifugal forces.

Work on the M75 weapon ceased in 1967 when the XM129 was sufficiently developed to take its place. The major problem with the M75 was the torque created due to the barrel being below the operating drum. In the XM129 the barrel is concentric with the drum and the excessive torque is thus eliminated.

Description and Purpose

The M75 is a single barrel power-driven 40mm High Velocity Grenade Launcher. The M75 was designed as an area suppressive fire system for helicopters. The gun itself fires a 40mm grenade cartridge from a linked metallic belt.

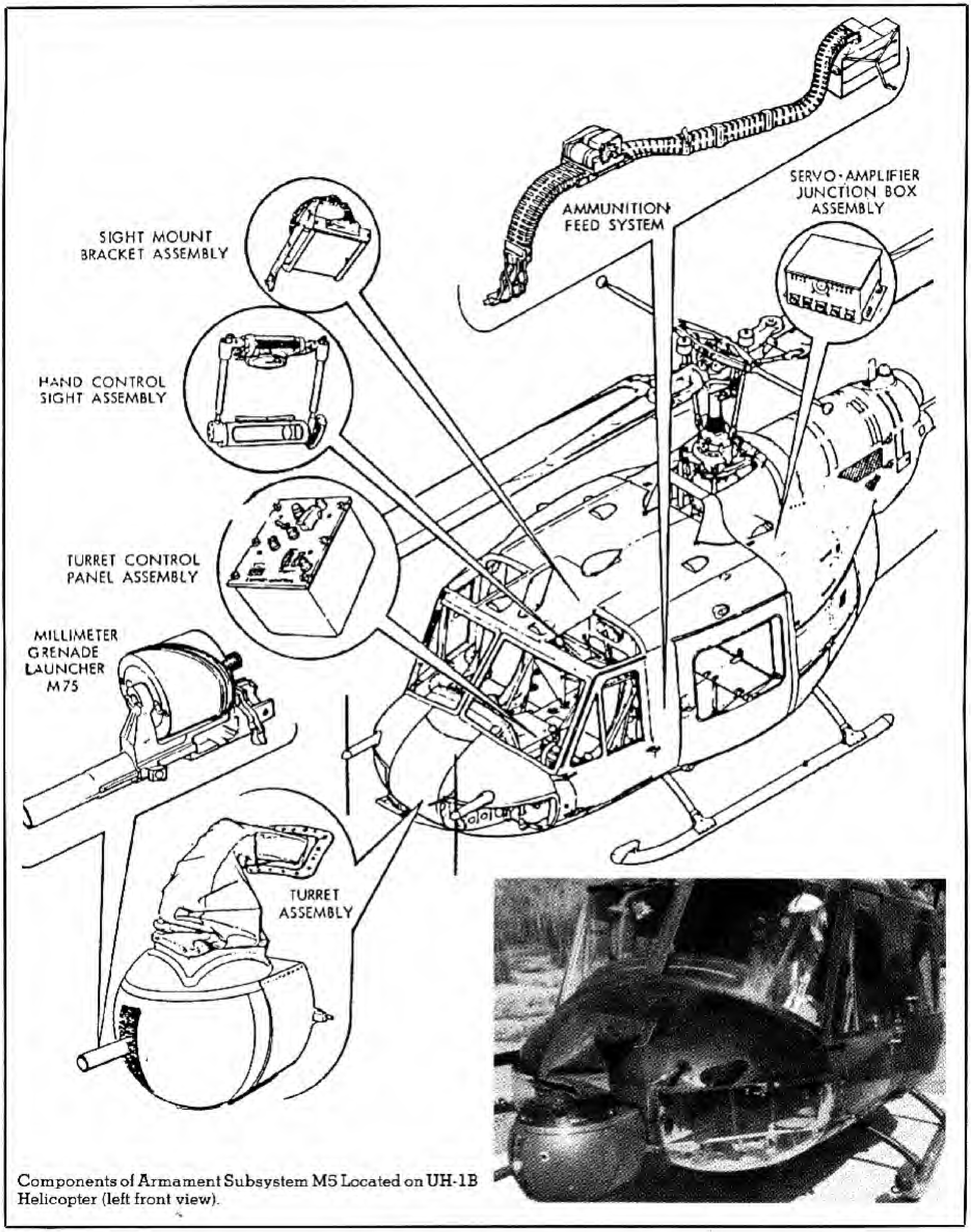
The major components of the M75 weapon are the drive motor, drum cam, receiver, barrel, and feed tray. The weapon is powered by a 5/8 horsepower, 28 volt DC motor, and is so constructed that all phases of the weapon cycle are positively controlled by the drum cam assembly. The drum cam encloses the planetary gear train, which reduces the high motor speed to the desired rate for the gun. The motor is mounted on the turret bracket and drives the drum cam through a flexible shaft. In this manner the motor is isolated from the weapon and it is not adversely affected by recoil.

Since the M75 gun was only used in the M5 system, a description of the M5 system is in order.

The M5, designed and manufactured by General Electric and sponsored by U.S. Army Weapons Command's Springfield Armory, was used on the UH-IB/C/M helicopters, and consisted of a flexible, remote controlled, power driven gun turret mounted in the nose of the helicopters. The turret incorporates one M75 grenade launcher. Linked ammunition is stored in a 302 round rotary ammo drum in the cargo hookhole, pulled through a flexible chute by an ammo booster, and fed to the grenade launcher. A master armament control is located in the instrument console and is accessible to both the pilot and co-pilot (gunner). A flexible hand control sight assembly mounts above the co-pilot's seat from which the co-pilot can sight and fire the system. The subsystem could also be fired in the "stow" position by either the pilot or co-pilot by means of a trigger switch on both grips. In this mode, the turret is flexible in elevation. The entire system, loaded, weighs 484 lbs.

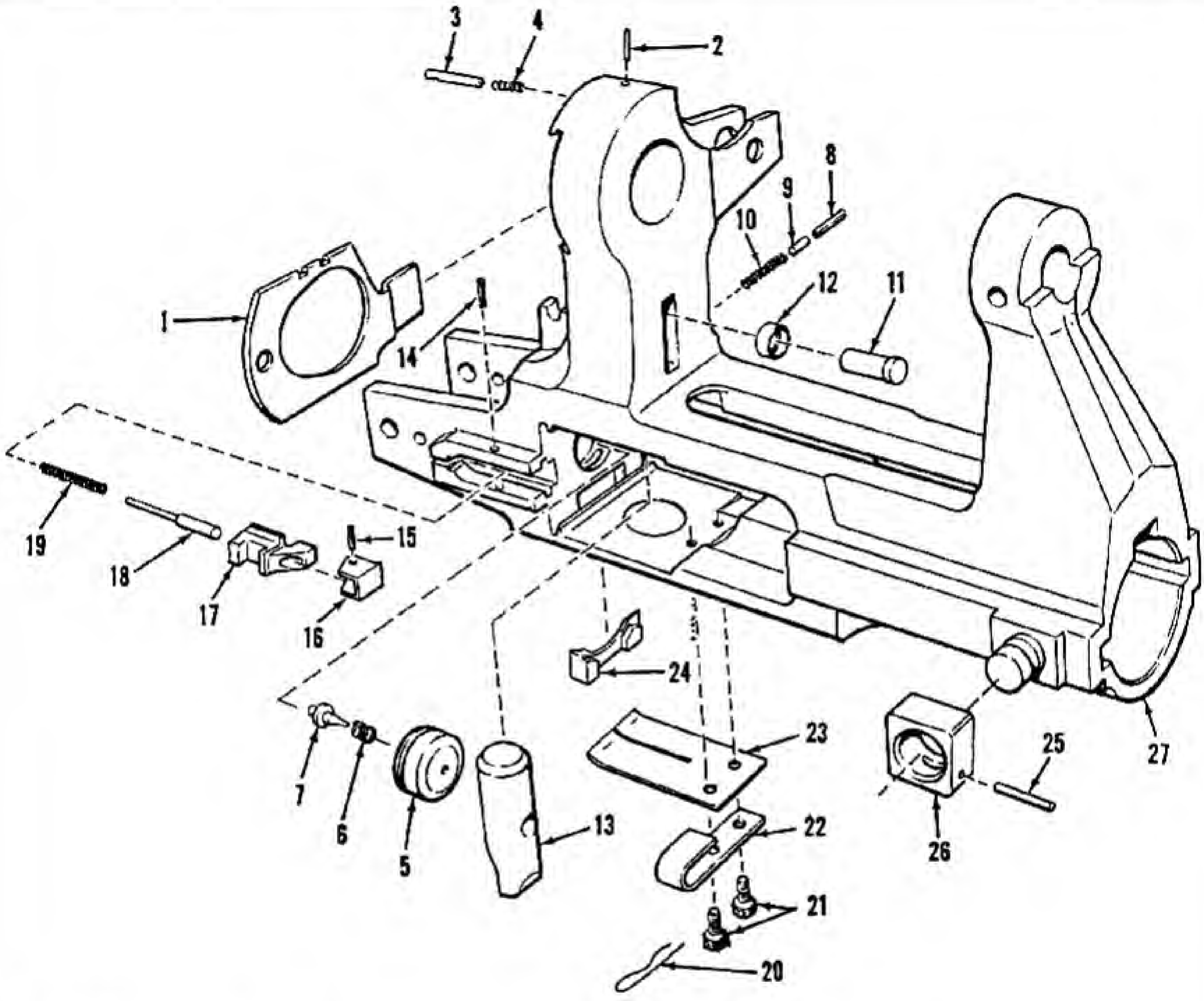
Characteristics

Bore Size	40mm
Muzzle Velocity	790 fps
Rate of Fire	225 rpm
Basic System of Operation	Power Driven
Locking System	Other
Power Source Feed System	Power Driven
Feed System	Cam Operated
Type of Feed (location)	Belt
Method of Chambering	Other
Type of Accelerator	None
Initial Extraction	None
Type of Receiver	Machined
Weapon by Source	U.S. Army
Manufacturer	Philco-Ford
Developer	Philco-Ford
Ammunition	M384
Length	22.5 in.
Width	8 in.
Height	9 in.
Weight	27 lb.
Barrel Length	13.7 in.
Number of Grooves	18
Twist	1 turn - 48 ins. R.H.
Type of Firing Mechanism (Firing Pin)	Percussion
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Electro-Mechanical


AMMUNITION FEED SYSTEM
SERVO-AMPLIFIER JUNCTION BOX ASSEMBLY
SIGHT MOUNT BRACKET ASSEMBLY
HAND CONTROL SIGHT ASSEMBLY
TURRET CONTROL PANEL ASSEMBLY
MILLIMETER GRENADE LAUNCHER M75
TURRET ASSEMBLY

Components of Armament Subsystem M5 Located on UH-1B Helicopter (left front view).

and has an effective range of 1,640 yards, with a muzzle velocity of 790 feet per second. The rate of fire is 230 rounds per minute. The mounts elevation is +15° and the depression is -35°. The traverse is 60° both right and left.



1—Spindle assembly retainer
2—3/32 x 1/2 spring pin
3—Spindle retainer pin
4—Retainer pin compression helical spring

5—Breech insert
6—Firing pin compression helical spring

7—Firing pin
8—Spring pin
9—Barrel insert retaining pin
10—Insert retaining pin compression helical spring

11—Barrel lock pin
12—Barrel lock roller

13—Barrel lock
14—0.094 x 3/4 spring pin
15—3/32 x 3/8 spring pin
16—Cartridge stop pawl
17—Cartridge stop
18—Cartridge stop plunger
19—Plunger compression helical spring
20—Corrosion resisting steel wire
21—Link stop screw
22—Link stop 1010-
23—Cartridge positioner spring
24—Cartridge positioner
25—0.094 x 7/8 spring pin
26—Receiver block
27—Receiver

Receiver Assembly (Partially Exploded View)

Cycle of Operation

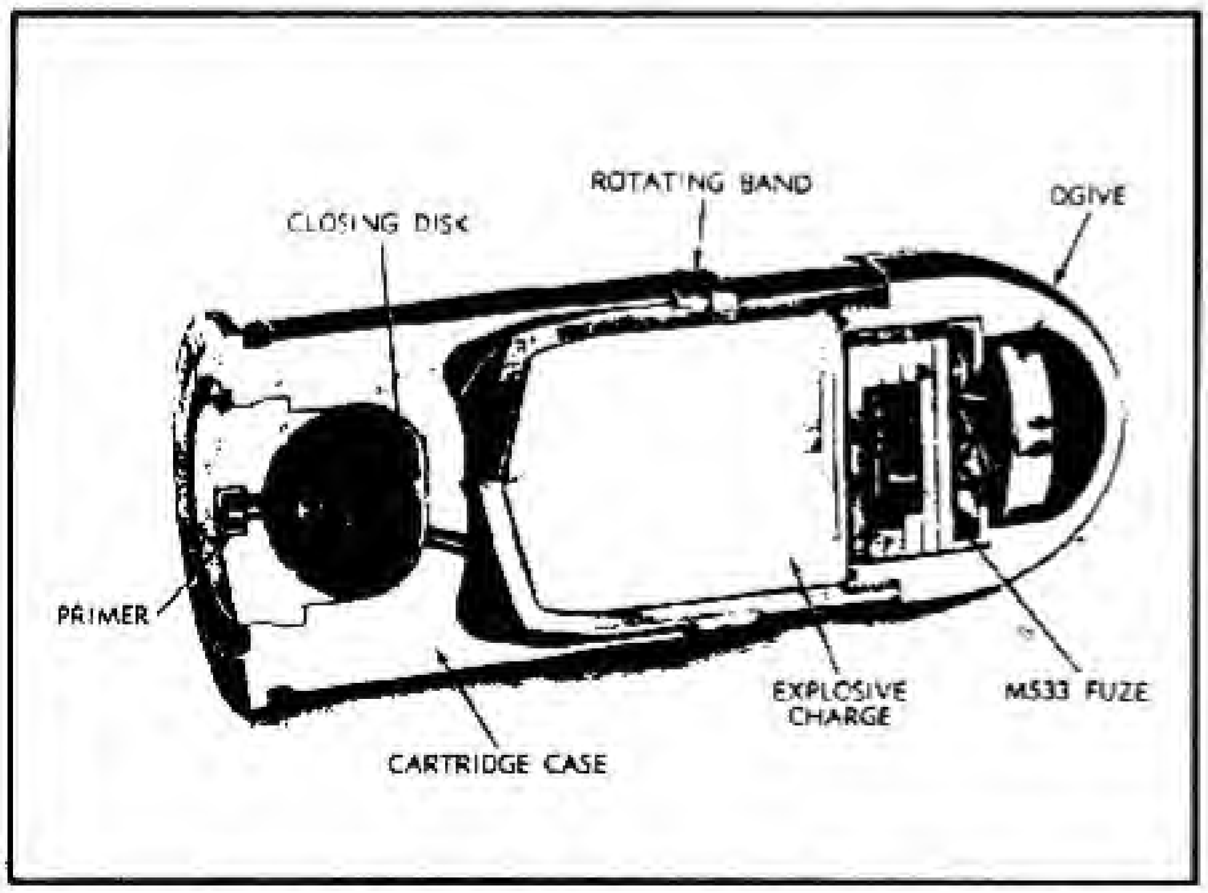
The drum cam is the principal weapon control element and contains three synchronized cams, a peripheral cam and two faceplate cams. It is cradled in the receiver, which also houses the barrel, barrel lock, firing mechanism, and feed components. The peripheral cam on the drum is the barrel-actuating cam. It engages a lug on the barrel that reciprocates the barrel through one forward and aft motion per revolution of the drum. On the barrel's rearward stroke, the barrel telescopes over the cartridge and engages the link, stripping it rearward on the cartridge case, and, at the same time, disengaging the link from the rest of the belt. Near the end of the rearward stroke, the barrel cocks the firing mechanism. The barrel remains in this rearward, or battery, position while the drum continues to rotate through 40° to ensure that primer ignition, propellant burning, and bullet exit from the muzzle take place while the barrel is locked in barrel. During the barrel dwell, the barrel locking cam engages the barrel lock, moving it into the recess in the barrel, locking the barrel, and, at the same time, actuating the sear release and releasing the striker. This mechanical arrangement provides a dual safety feature wherein, first, the firing mechanism cannot be cocked until the barrel has moved into battery position and, second, the firing mechanism cannot be released until the barrel is locked.

Each fired case is extracted on the forward stroke of the barrel, as the case is held by the T slot in the receiver. The barrel approaches the forward position and the feed cycle begins. Feeding is controlled by the feed cam, which actuates the feed arm pivoting about a fixed point on the receiver so that the feed pawl, which intrudes into the feed tray, pushes the leading round of the ammunition belt into the T slot in the receiver. This round displaces and ejects the previously fired cartridge case and link. Feeding is accomplished after the weapon has recoiled and returned to a stationary position.

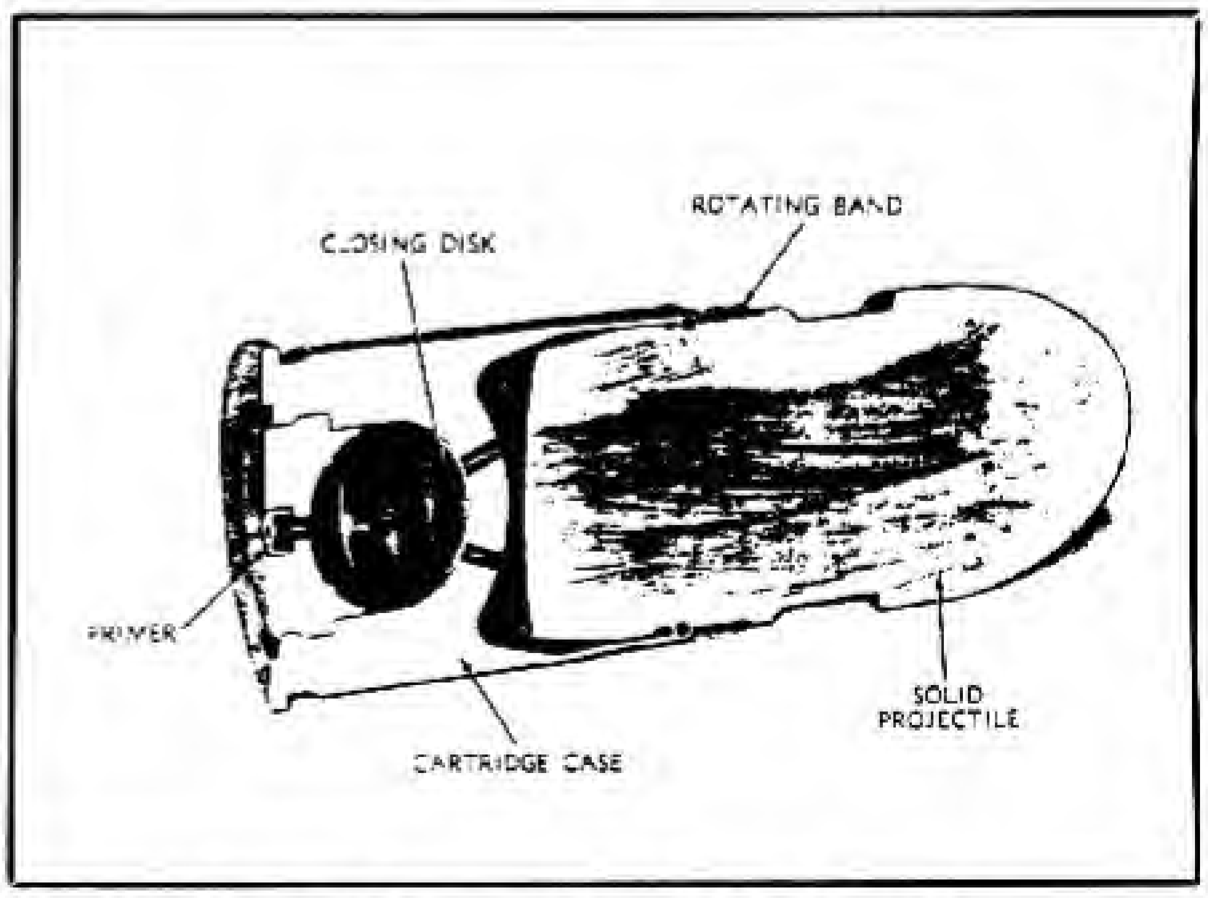
Test Results

Ground and air tests of the prototype installation, which culminated in a successful aerial firing demonstration with high explosive rounds in June 1961, was followed by extensive redesign and tests of the entire armament subsystem. The armament supplies 30 seconds of continuous fire with controls for traverse and elevation. Since the accuracy of point fire was not required and since the operator can direct fire according to his observation of strikes, the sight mechanism met the Army's sighting and aiming requirements. Despite success of these tests with a single 40mm launcher in the nose of a helicopter, the Combat Developments Command indicated a preference for dual installation in the UH-1B aircraft. The development of this dual installation began in fiscal year 1964, while continuing development of the M5 system. However, the requirement for a dual installation for the M75 was dropped because of the development of the more advanced XM129 40mm grenade launcher.

The final report on the Initial Production Test of the M5 system was published in late 1967 and recomended the redesign of some parts to improve the life of the system.



Cutaway View of High Explosive 40mm M384 Cartridge

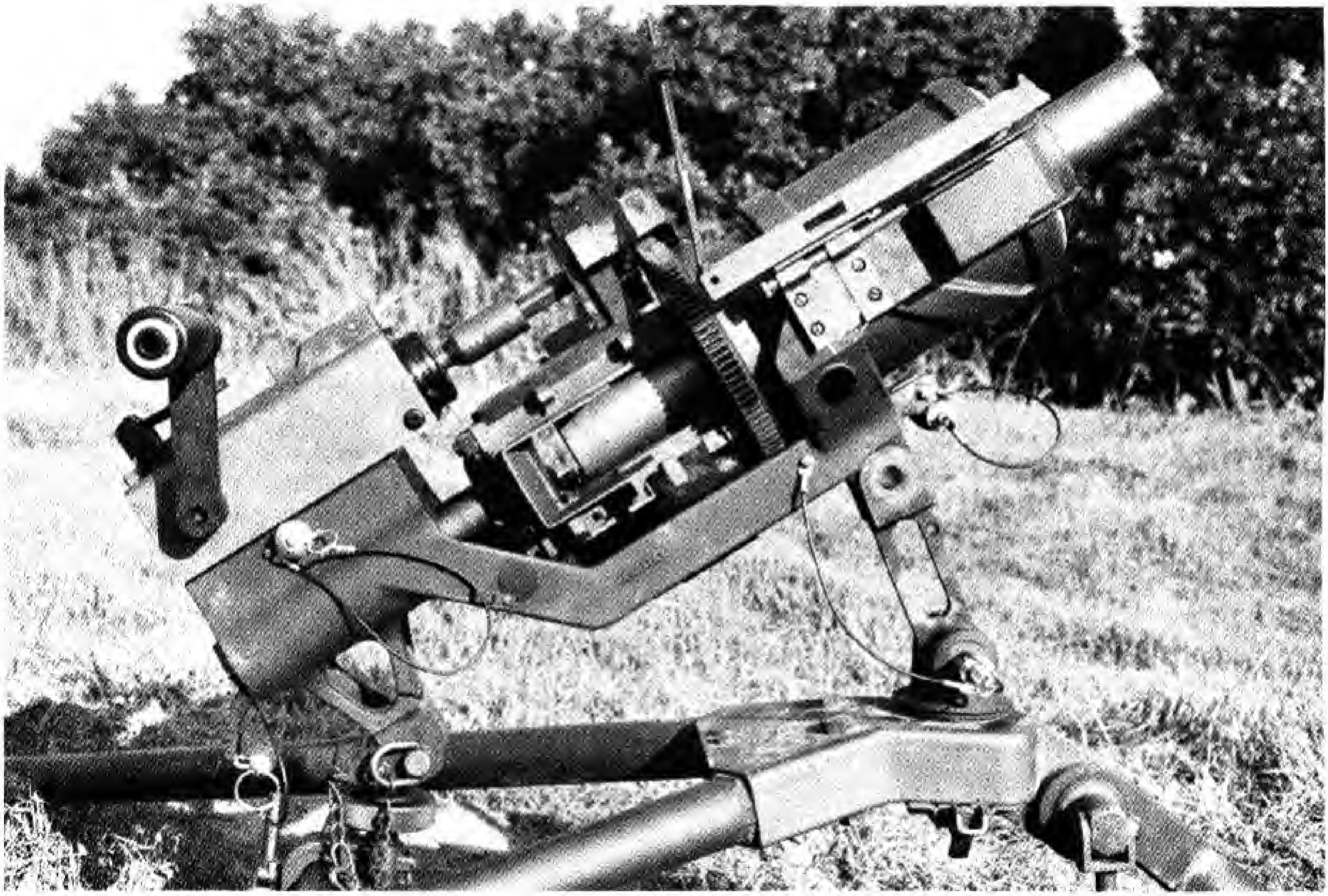


Cutaway View of Practice 40mm M385 Cartridge

Chapter 60

40mm XM129 GRENADE LAUNCHER HIGH VELOCITY

PHILCO-FORD, MAREMONT CORPORATION



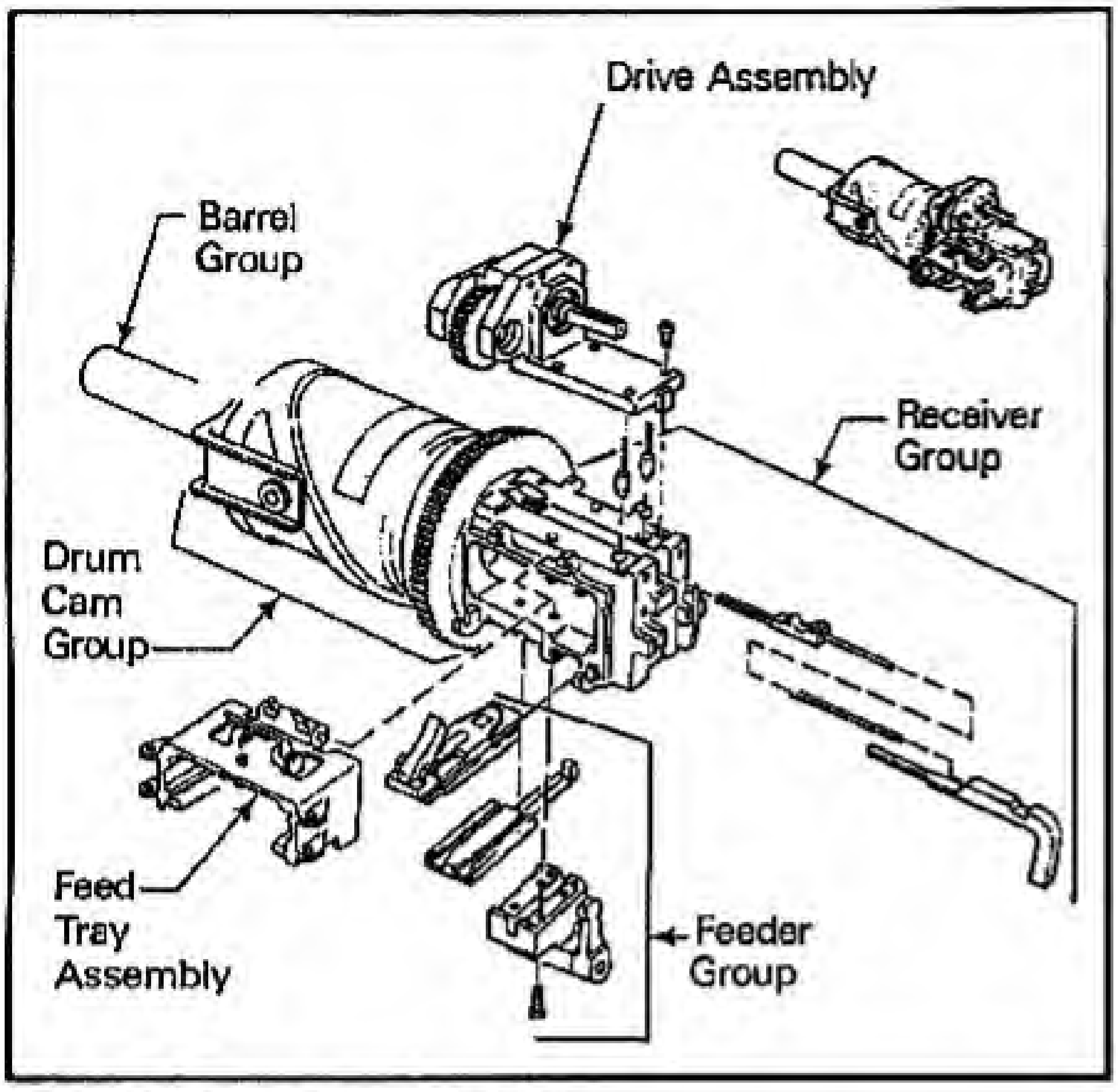
40mm XM129 High Velocity Grenade Launcher

History

Work began on the XM129 in 1963 for the purpose of reducing the mounting difficulties inherent in the M75 Grenade Launcher. However, the basic principle of operation remained identical with the M75.

Between 1963 and 1971, Philco-Ford's Aeronutronic Division developed the weapon and produced the first 1,355 guns for use on the M28 and XM51 helicopter armament subsystems. Those systems were for use on the Cobra and Cheyenne helicopters, respectively.

In 1966 and 1967, Philco-Ford developed the



XM129 40mm Exploded View

XM173 hand cranked version of the XM129 for ground use. A total of six of these guns were made and evaluated.

In 1967 through 1968, a modification of the M5 armament subsystem was done by Philco-Ford to allow the M129 to replace the M75 in that subsystem. Two years later a soft mount for the M129 in the M28 armament subsystem was developed.

1968 saw the beginning of work on a pintle and cupola mount for the M129. This program was for the development and fabrication of 102 weapons.

The XM129 Grenade Launcher has been in production by Maremont Corporation since 1972.

Description and Purpose

The XM129, a lightweight, externally powered, grenade launcher, fires the 40mm, high-velocity, ammunition. A gear train rotates a drum cam which is mounted concentric to the bore. The cam reciprocates the barrel one full cycle per revolution of the drum cam. The functions of feeding and firing are similarly governed. The XM129 can be powered by a motor or hand crank at rates up to 440 rpm, and can be assembled to feed from either side.

The XM129, an area target and suppressive fire weapon, is used in the Helicopter Armament Subsystem for the AH-IG Cobra Helicopter and in the XM8 subsystem for the OH-6A and OH-58A Helicopters. It was also used in the Cheyenne Helicopter. The XM129 grenade launcher was also used to replace M75 launchers in the M5 subsystem on UH-IB/C Helicopters.

In addition to these applications, the weapon was a candidate for use on riverine craft and ground vehicles.

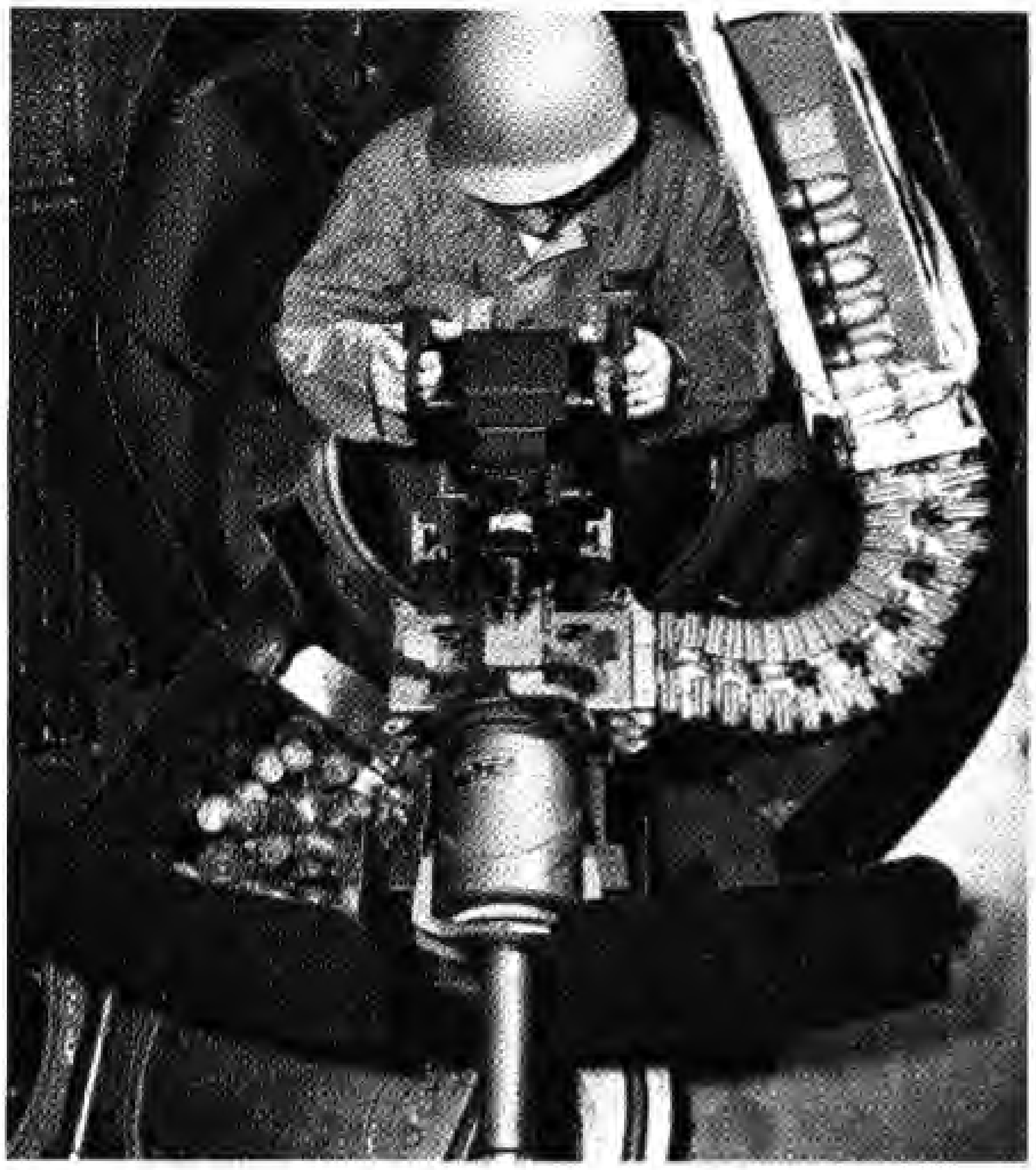
The main reason for the design of the XM129 was to eliminate the mounting difficulties of the M75 Grenade Launcher which were caused by the barrel being positioned below the operating drum. So, the XM129's barrel is concentric with the drum which reciprocates the barrel.

Cycle of Operation

When the proper clockwise torque is applied by the electric motor to the drive assembly, the lock and feed cam assembly and the drum and cup assembly rotate together. During this rotation the roller of the feed actuator assembly follows a track in the feed

Characteristics

Bore Size	40mm
Muzzle Velocity	790 fps
Rate of Fire	440 rpm
Basic Systems of Operation	Power Driven
Locking System	other
Power Source Feed System	Power Driven
Feed System	Cam Operated
Type of Feed (location)	Link
Method of Chambering	other
Type of Accelerator	None
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	U.S. Army
Manufacturer	Philco-Ford
Utilization	Helicopter
Ammunition Type	M384, M385
Overall:	
Length	23.5 in.
Width	8.9 in.
Height	9.2 in.
Weight	43 lb.
Barrel Length	16.5 in.
Number of Grooves	18
Twist	1 turn - 48 ins. R.lt.
Type of Firing Mechanism	Percussion
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Fixed
Type of Bleech Mechanism	Electro Mechanical



XM129 in Use

cam portion of the lock and feed cam assembly. The feed actuator assembly transmits driving motion to the feed slide assembly, which moves to the right to secure a cartridge. The feed slide assembly pushed the cartridge into the receiver, where the cartridge stop and the cartridge positioner locate the cartridge properly.

The barrel assembly roller fits into the cam track on the inner surface of the drum and cup assembly. As the drum and cup assembly rotates, the barrel assembly is moved back over the positioned cartridge and the cartridge link is separated from the link of the next cartridge. When the barrel assembly is at the rearmost part of its travel the barrel lock assembly is cammed down to secure the barrel assembly during the cartridge firing.

Rearward movement of the barrel assembly also cocks the launcher for firing. A segment of the lock cam groove presses down on one end of a sear release, allowing the sear to move forward and freeing the hammer block, which hits the striker. The striker, in turn, hits the firing pin assembly, driving it into the cartridge primer.

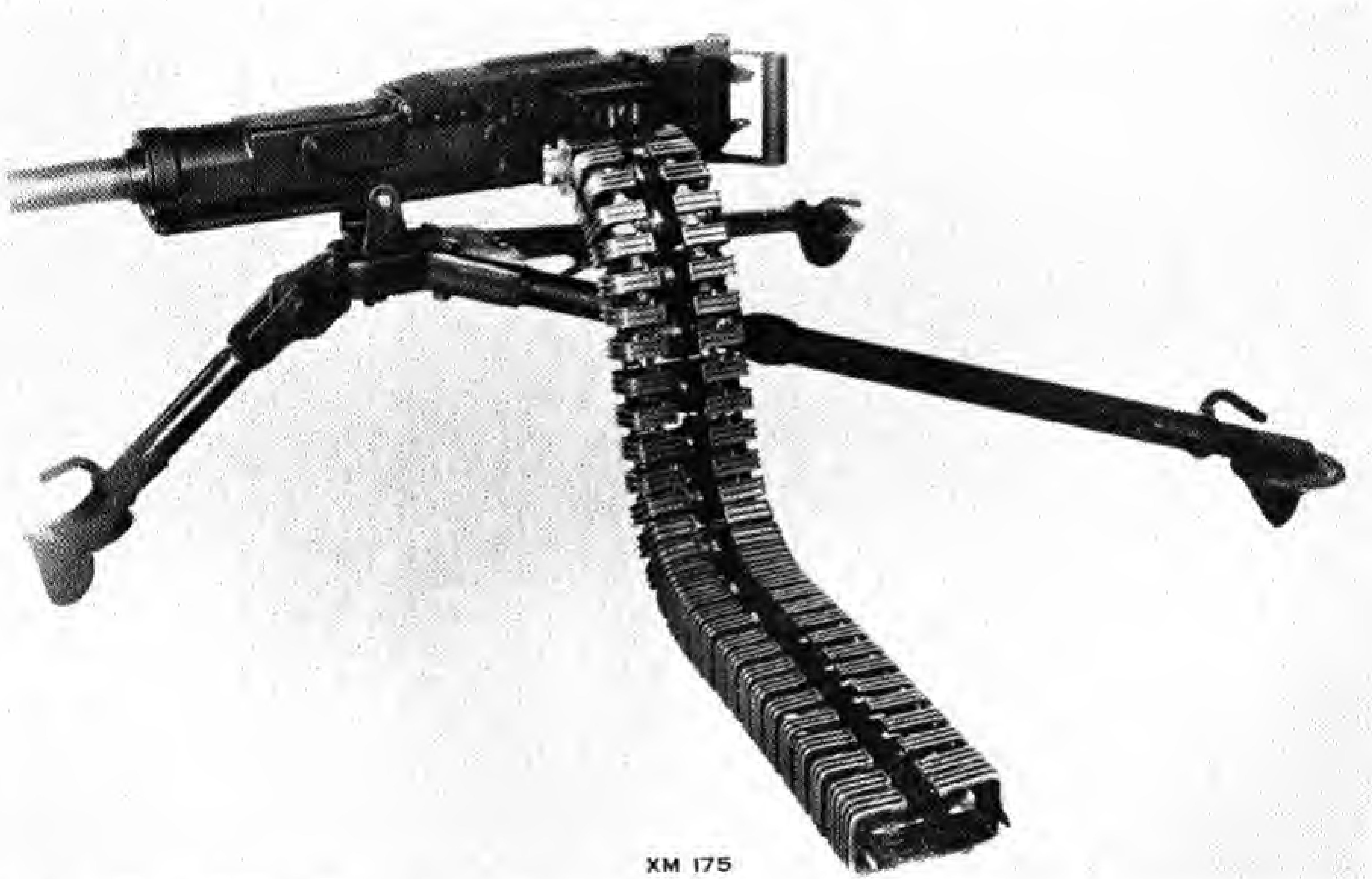
After the projectile has left the barrel assembly the barrel lock assembly is retracted and the barrel is cammed forward. A new cartridge is fed into the receiver assembly, pushing the spent cartridge out.

The gun drive motor operates on a nominal voltage of 28 volts DC. The motor is bolted on the rear of the weapon cradle and is connected to the weapon by a male and a female splined drive shaft. The motor operates at 8,000 rpm, which is reduced by gears to the weapon drum speed of 400 rpm. The motor starts immediately when the trigger is depressed. When the trigger is released the electrical system automatically initiates a time delay, senses the weapon drum position, and reverses the field connections to provide dynamic braking of the motor. One round is fired after the trigger is released, but the dynamic braking prevents a second round from chambering. These actions normally occur within a maximum of 1.5 revoltuions of the weapon drum. The weapon is stopped when the barrel is forward and safe.

XM129 on Helicopter

40mm HIGH VELOCITY XM175 GRENADE LAUNCHER

HUGHES TOOL COMPANY (Presently McDonnell Douglas)

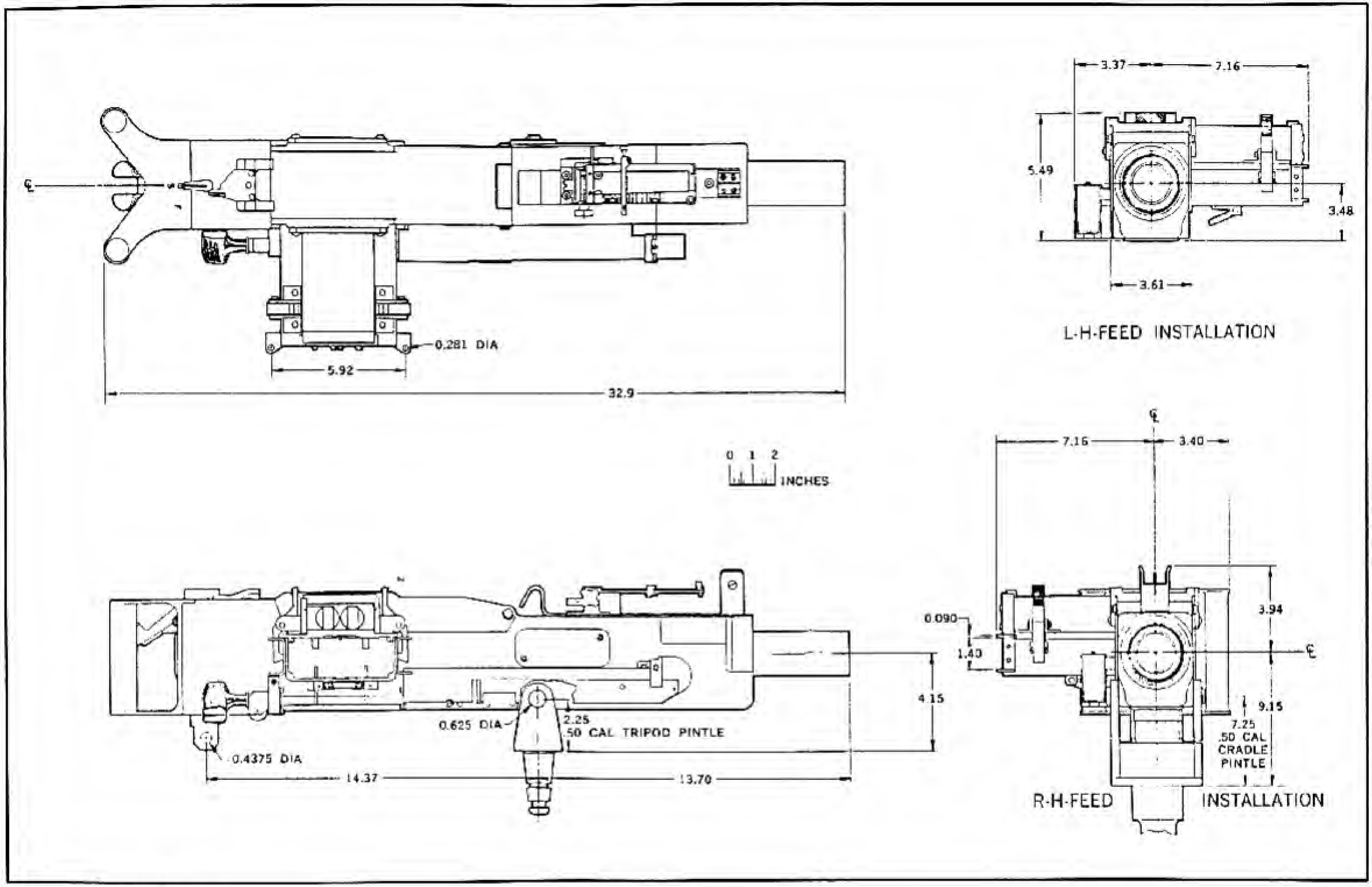


40mm XM175 High Velocity Grenade Launcher

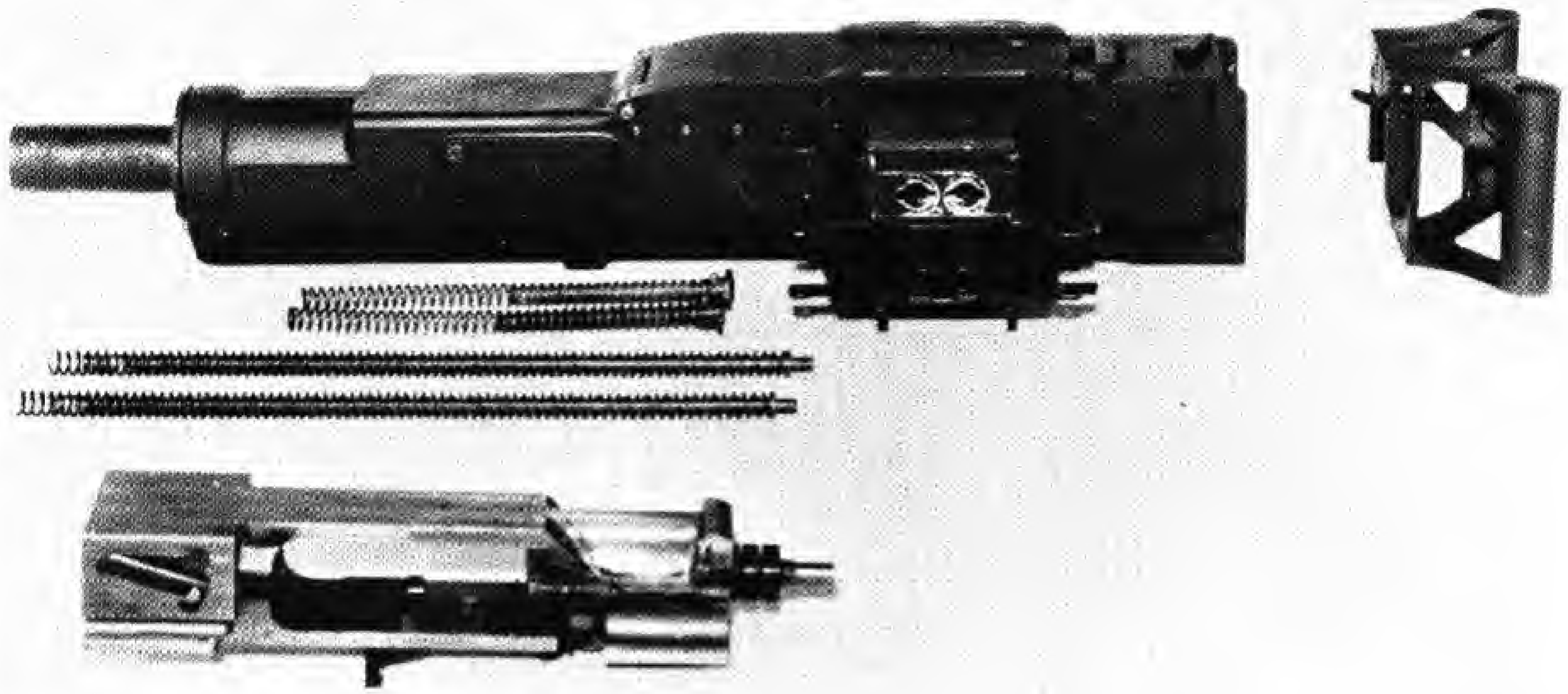
History

In April 1964, the Hughes Tool Company won a competitive contract from Springfield Armory for the fabrication and test of one 40mm High Velocity Grenade Launcher. The development weapon was based on an original Springfield concept which had as its technical objective to provide a compact, lightweight weapon to replace the calibre .50 machine gun on certain combat and tactical vehicles where area coverage and casualty probability against personnel is the primary consideration.

The first contract awarded by Springfield Armory in 1964, called for the fabrication and test of one weapon. This contract was modified in November 1965 to provide for the fabrication of a second gun.


3.37
7.16
5.49
3.48
3.61
L-H-FEED INSTALLATION
0.281 DIA
5.92
32.9
0 1 2
INCHES
7.16
3.40
3.94
0.090
1.40
4.15
9.15
7.25
.50 CAL
CRADLE
PINTLE
R-H-FEED INSTALLATION
0.625 DIA
2.25
.50 CAL TRIPOD PINTLE
0.4375 DIA
14.37
13.70

XM175 Exploded View



40mm XM175 Grenade Launcher Unassembled

Description and Purpose

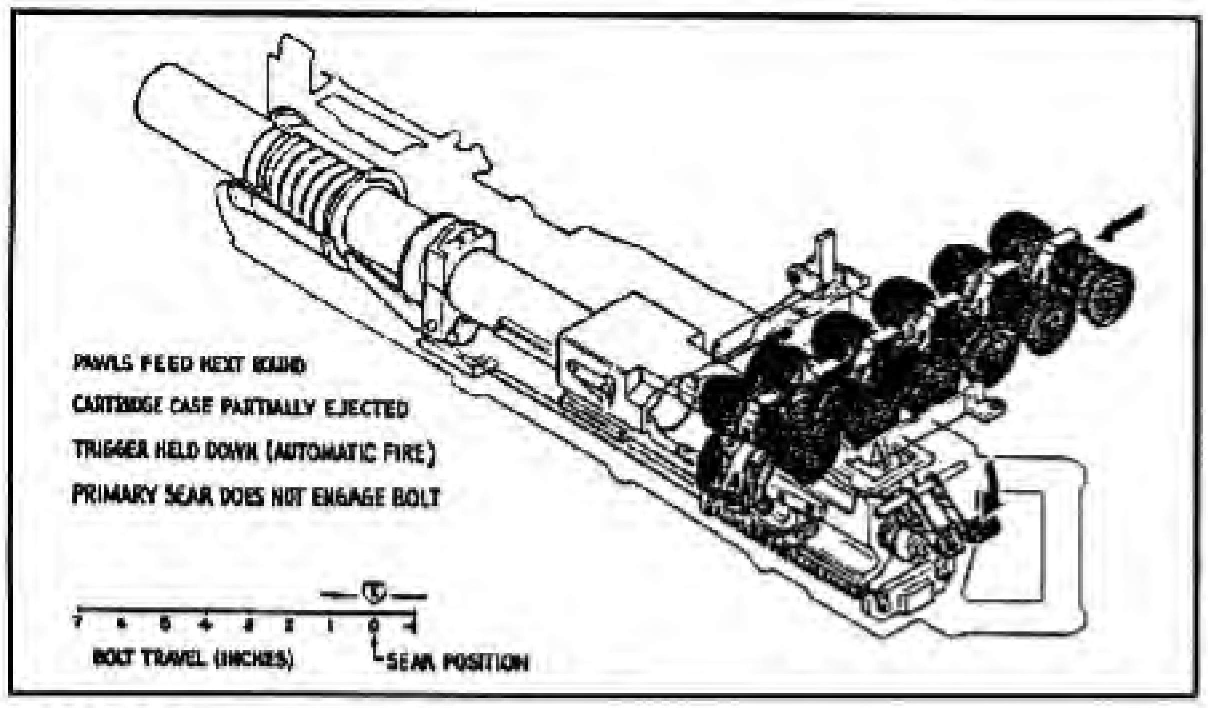
The 40mm High Velocity XM175 Grenade Launcher is a lightweight, short-recoil operated, automatic weapon that fires the high velocity series of 40mm grenade ammunition at a rate of 350 rounds per minute. The grenade launcher is self-powered, belt-fed using metallic links, and percussion fired. The launcher can be assembled for either left-hand or right-hand feed without additional parts. The receiver is equipped with a folding leaf-type rear sight and a guarded post front sight. For normal operations, the launcher is pintle-mounted, and a lightweight flexible chute conveys linked ammunition from an ammunition box to the feed tray. Both ends of the feed chute are provided with quick-release fasteners for ease of connection. The feed chute contains approximately 20 rounds of ammunition when loaded, and a second length of ammunition can be linked to the first to provide a total of 40 rounds at the ready condition.

Cycle of Operation

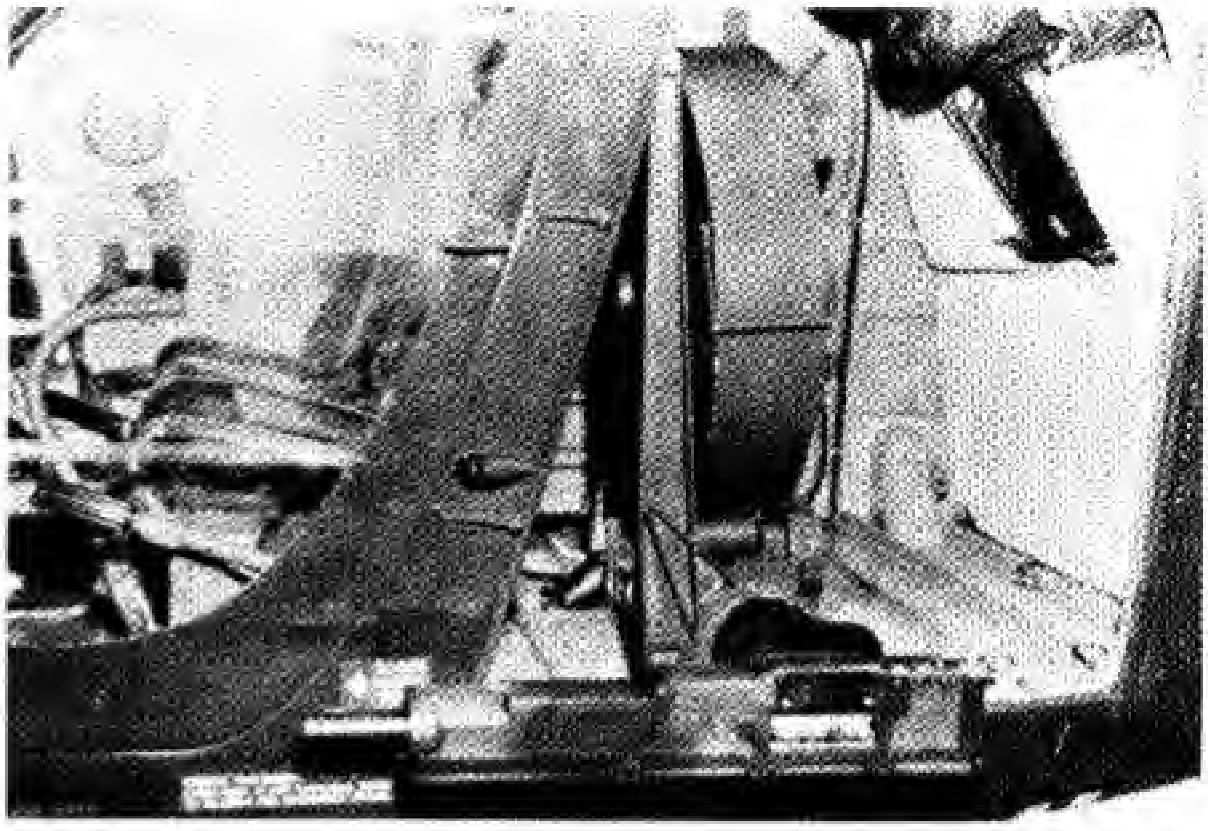
When the trigger is depressed, the sear retaining the bolt is lifted sufficiently to disengage from the bolt, allowing the bolt assembly to be driven toward battery by the drive springs. As the bolt advances, it delinks a round from the belt and rams it into the barrel, stripping back the link on the round approximately 1⅜ inches.

When stripping is completed, the forward end of the bolt strikes the aft end of the barrel lock, causing it to rotate and release from the rear buffer ring. At the same time, the bolt locks drop in front of the barrel lugs and lock the barrel and bolt together; the unit now accelerates toward battery. Just prior to reaching the battery position, the bolt hammer contacts the actuating rod, causing the hammer to rotate and strike the firing pin. The round fires and initiates the recoil of the barrel and bolt. During the first 2.0 inches of recoil, the feed cam attached to the barrel cocks the feeder by means of the feed lever. At a point 2¼ inches aft of battery, with recoiling bolt assembly, the cam plates move the bolt locks out of engagement with the barrel lugs and enable the barrel to separate from the bolt.

When the barrel contacts the front buffer ring, the buffer is compressed and absorbs the energy of the barrel. At the same time, the initial overtravel of the barrel forces the barrel lock to be cammed up by the barrel lock cam. Upon counterrecoil of the barrel, the barrel lock strikes the rear buffer ring and retains the barrel in this position for the next cycle. The bolt


PAWLS FEED NEXT ROUND
CARTRIDGE CASE PARTIALLY EJECTED
TRIGGER HELD DOWN (AUTOMATIC FIRE)
PRIMARY SEAR DOES NOT ENGAGE BOLT
7 6 5 4 3 2 1 0
BOLT TRAVEL (INCHES)
SEAR POSITION

XM175 Operating Cycle



Self-powered XM175 on Helicopter

Characteristics

Bore Size	40mm
Muzzle Velocity	790 fps
Rate of Fire	350 rpm
Basic System of Operation	Recoil
Locking System	Propped Lock
Power Source Feed System	Recoil
Feed System	Lever Type
Type of Feed (location)	Link
Method of Chambering	Ram
Type of Accelerator	None
Initial Extraction	Mechanical
Type of Receiver	Machined
Weapon by Source	U.S. Army
Manufacturer	Hughes
Developer	Hughes
Ammunition:	
Type	M384
Performance Date (range)	2200 m
Gun Size:	
Length	35.4 in.
Width	9 in.
Height	5.5 in.
Weight	35 lb.
Barrel Length	19.7 in.
Number of Grooves	18
Twist	1 turn - 48 ins. R.H.
Type of Firing Mechanism (firing pin)	Percussion
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Manual
Type of Breech Mechanism	N/A

continues aft, extracting the spent case from the barrel. As the bolt reaches the full sear position, it overtravels until such time as the bolt buffer hits the backplate and the excess energy is dissipated. On rebound, the bolt engages the primary sear and drives the feed trip attached to the end of the sear forward 0.20 inches, which gives the feeder sear a signal to release the feed plate and load a new round. The feed plate, by means of the feed pawls, places a new cartridge in the bolt retaining ways, at the same time ejecting the empty previously fired case. During the action of feeding the new cartridge, the feed release moves with the feed plate and at the end of the feed cycle engages a camming surface machined into the feed trip, thus forcing the primary sear to rotate and unsear the bolt. This allows the bolt to be driven toward battery by the drive springs, and the cycle is repeated.

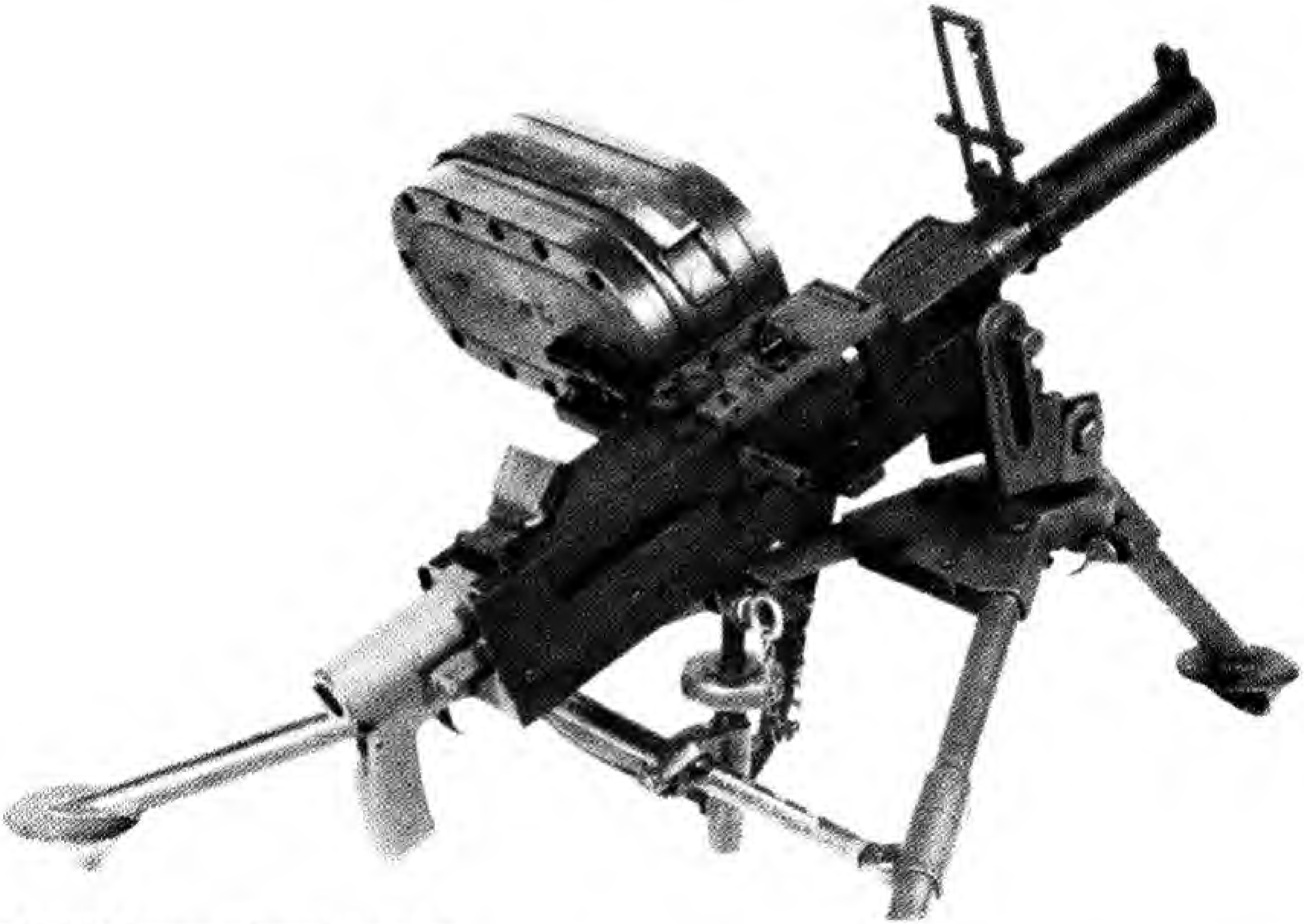
Test Results

In a year, over 100,000 rounds were fired during various tests and showed many outstanding features desired by the armed services in their continuous search for an automatic grenade launcher system that could fulfill all rigid requirements of the Army, Navy and Air Force.

Chapter 62

40mm XM174 AUTOMATIC GRENADE LAUNCHER

AEROJET



40mm XM174 Automatic Grenade Launcher

History

A requirement was stated by United States Military Assistance Command, Vietnam in 1964, based upon requests from the field, for a weapon system which could be vehicle-mounted and provide a high volume of area fire for counterambush. A request for such a system under ENSURE procedures was formalized 8 March 1966. Tests were conducted on four different 40mm grenade launcher systems. The systems included high and low velocity type weapons, each of which was hand-cranked. These tests eliminated all but the XM174 automatic, low-velocity launcher. Ten of these weapons arrived in the field on 10 May 1968 accompanied by a project engineer from United States Army Weapons Command (USAWECOM).

Characteristics

Launcher Weight	16 lb.
Weight of Loaded 12-Round Magazine	10 lb.
Cyclic Rate of Fire	300 spm
Maximum Rate of Fire	100 spm
Operation	Direct Blowback
Function	Automatic or Semi-Automatic
Feed	Magazine (no links)
Maximum Range	400 meters
Ammunition	M406 40mm HE Cartridge

The XM174 Grenade Launcher was developed by Aerojet Ordnance Manufacturing Co. for the U.S. Army WECOM and with the U.S. Air Force and the U.S. Marine Corp and saw limited service.

Description

The XM174E3 40mm automatic grenade launcher is a compact, self-powered magazine-fed, automatic weapon. It is designed to fire standard U.S. low-velocity 40mm grenades which have a maximum range of 400 yards.

Ammunition is fed into the launcher from a 12-round, spring-operated magazine designed for quick installation and removal. The launcher uses a direct blowback action with a spring-operated ammunition feed mechanism. Ammunition is fed into the launcher from the left side, and cases are ejected through the port on the right side. Firing is from a closed-bolt position. A charging handle is located on the right side of the launcher, and a "selector" push-button is located in the pistol grip to permit selection of automatic or semiautomatic (single-round) fire.

Launchers may be pintle-mounted on armored vehicles, tripod-mounted (as an infantry crew-served weapon), or fired "from the hip". When launchers are fired from the hip, recoil velocity is less than that of the single-round, shoulder held M79 grenade launcher, which uses the same ammunition.

The XM174E3 40mm automatic grenade launcher is capable of rapidly delivering a large volume of high-explosive, anti-armor fragmenting projectiles to targets within a 400 yd. range. With this capability, the lethal area per minute and lethal area per pound of ammunition weight that can be delivered to a target are significantly greater than those available with any similar weapon. The high trajectory of the projectile permits effective attack of targets in defilade (targets that are invulnerable, or nearly so, to fire from flat-trajectory weapons). Consequently, the XM174E3 added versatility and intense firepower when properly employed in a weapons mix.

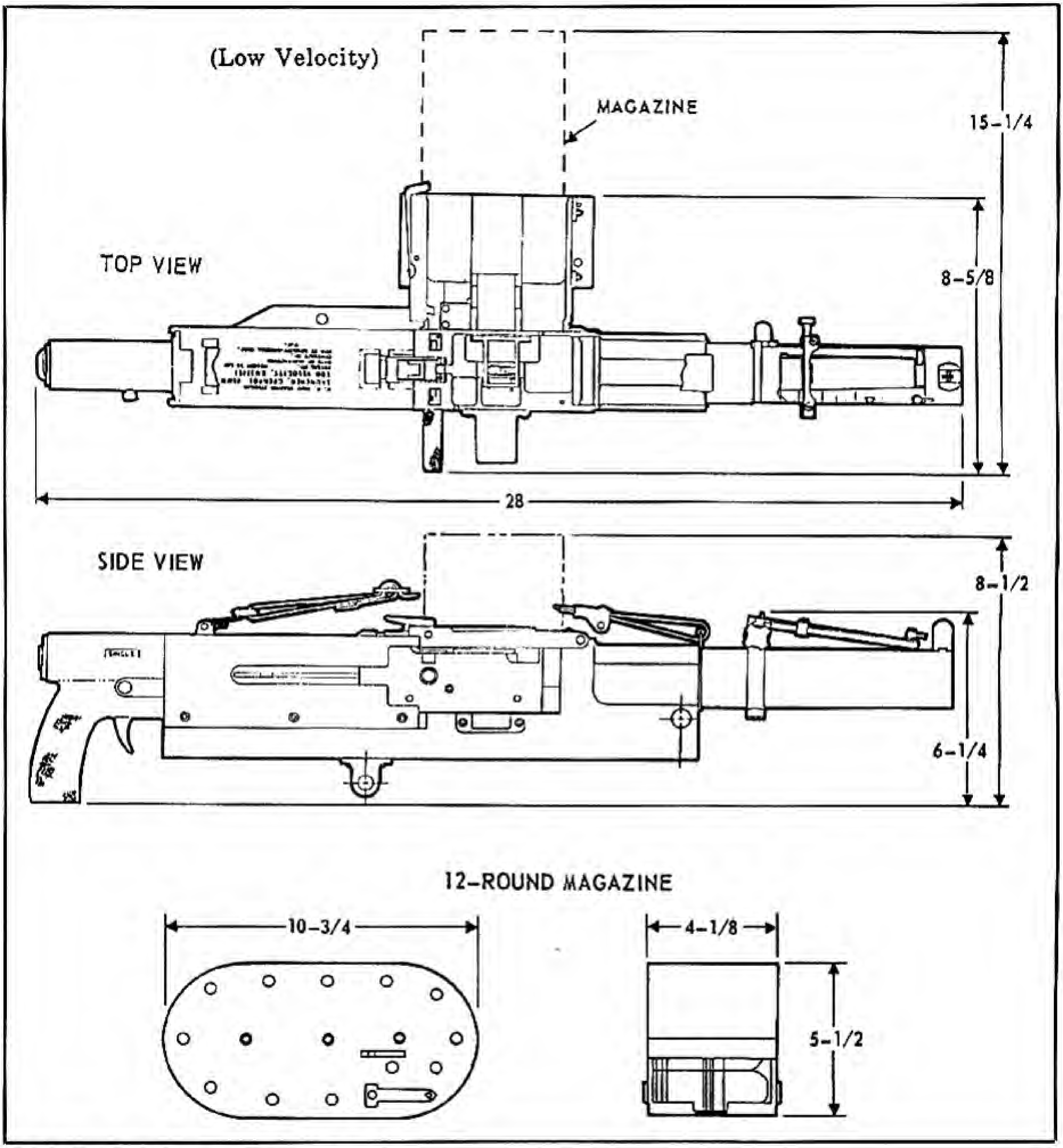
The XM174E3 40mm automatic grenade launcher has the following characteristics:

- Rapid response in a close-combat encounter
- Intense initial firepower
- Capability of defeating light armor, as well as personnel, to 400m range
- Greater mobility through lightweight design
- Proved simplicity and reliability
- Capability of defeating defiladed targets through indirect fire (because of the high, curved trajectory of the standard ammunition)
- Versatility in firing modes: tripod, bipod, hand-held hip-fired, or vehicle-mounted
- Reduced weight and volume of ammunition needed to defeat antipersonnel area targets within the weapon's range, as compared with a machine gun
- Military characteristics

Cycle of Operation

The XM174E2 is designed to fire the low velocity cartridges, practice round, and proof round. It uses a direct blowback action without bolt locks or fixed head space. The firing impulse applied to the projectile is balanced by an impulse applied to the relatively heavy bolt, causing it to recoil to the rear with an initial velocity of 23 feet/second. The kinematic energy of the bolt is used to cock the hammer, eject the empty case, compress the bolt return spring, and reciprocate the feed mechanism. The feed pawl picks up a cartridge from the feed tray and pushes it into the receiver opening, where it is chambered by the bolt on its return stroke. A spring drive mechanism conveys the rounds from the magazine to the feed position in the feed tray.

The firing mechanism consists of the firing pin, hammer, hammer sear, and operating springs, and is contained in the bolt. The hammer sear is operated by the trigger through the trigger bar in the receiver. The hammer is latched in the cocked position by the hammer sear. When the trigger bar is drawn to the rear, it disengages the hammer sear from the hammer. The hammer, driven by the hammer spring, rotates upward, striking the rear end of the firing pin. The firing pin is driven forward, impacting the cartridge primer, which fires the cartridge. As the bolt recoils rearward a cam surface in the

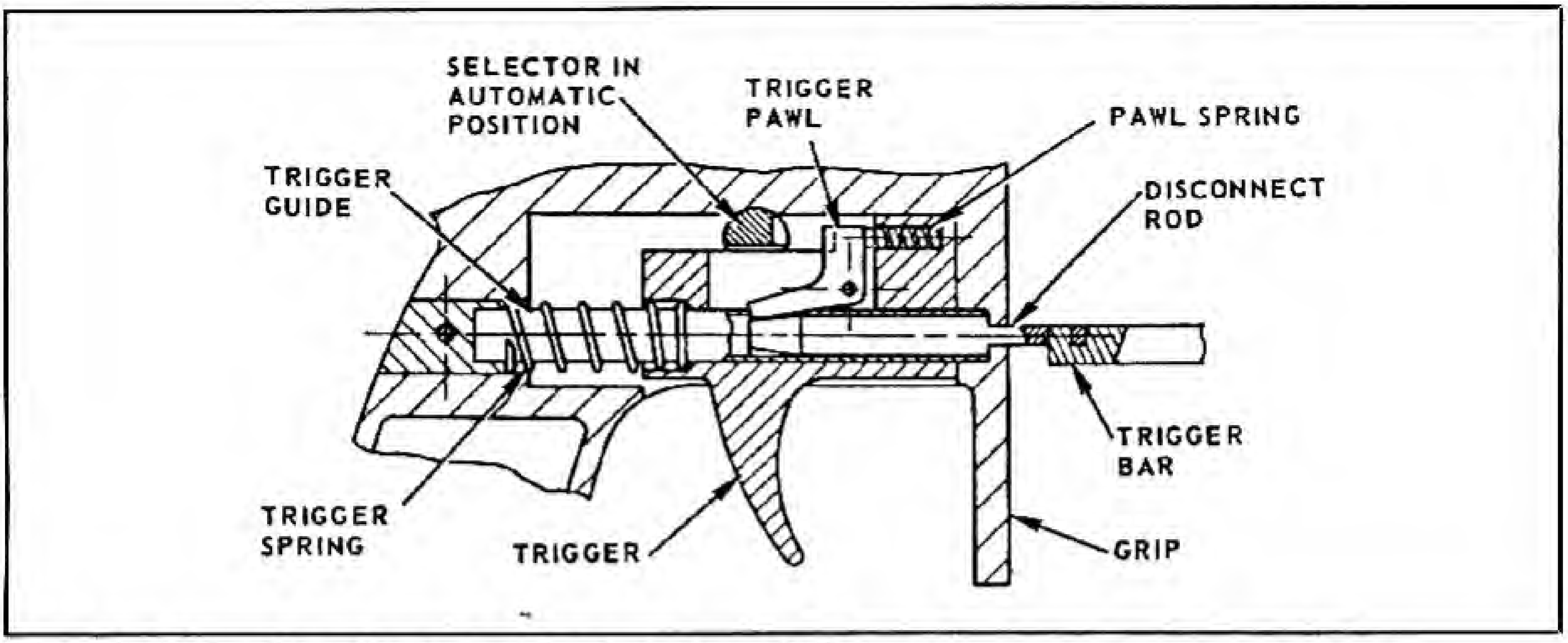

(Low Velocity)
MAGAZINE
15-1/4
TOP VIEW
8-5/8
28
SIDE VIEW
8-1/2
6-1/4
12-ROUND MAGAZINE
10-3/4
4-1/8
5-1/2

XM174E1 40mm Automatic Grenade Launcher

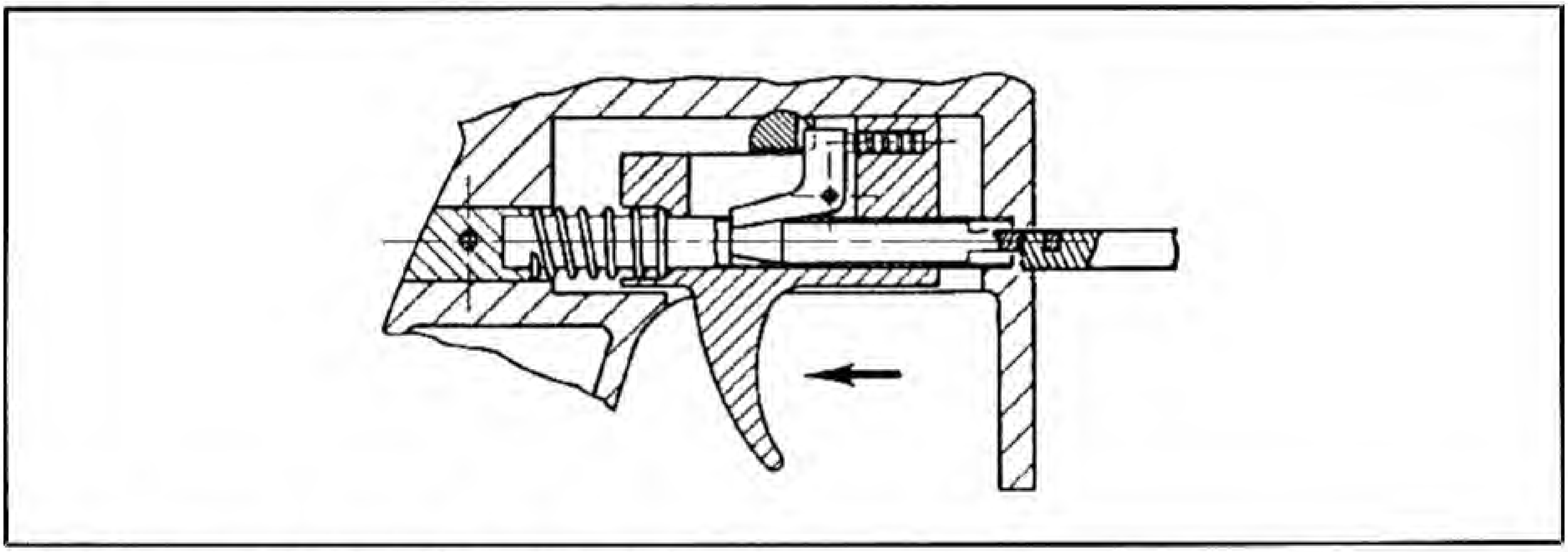
receiver cocks the hammer.

The sequence of operations of the grenade launcher in automatic fire is: the trigger and trigger bar are pulled to the rear, disengaging the hammer sear from the hammer. The hammer under spring pressure from the hammer spring, rotates upward, striking the firing pin, which ignites the percussion primer.

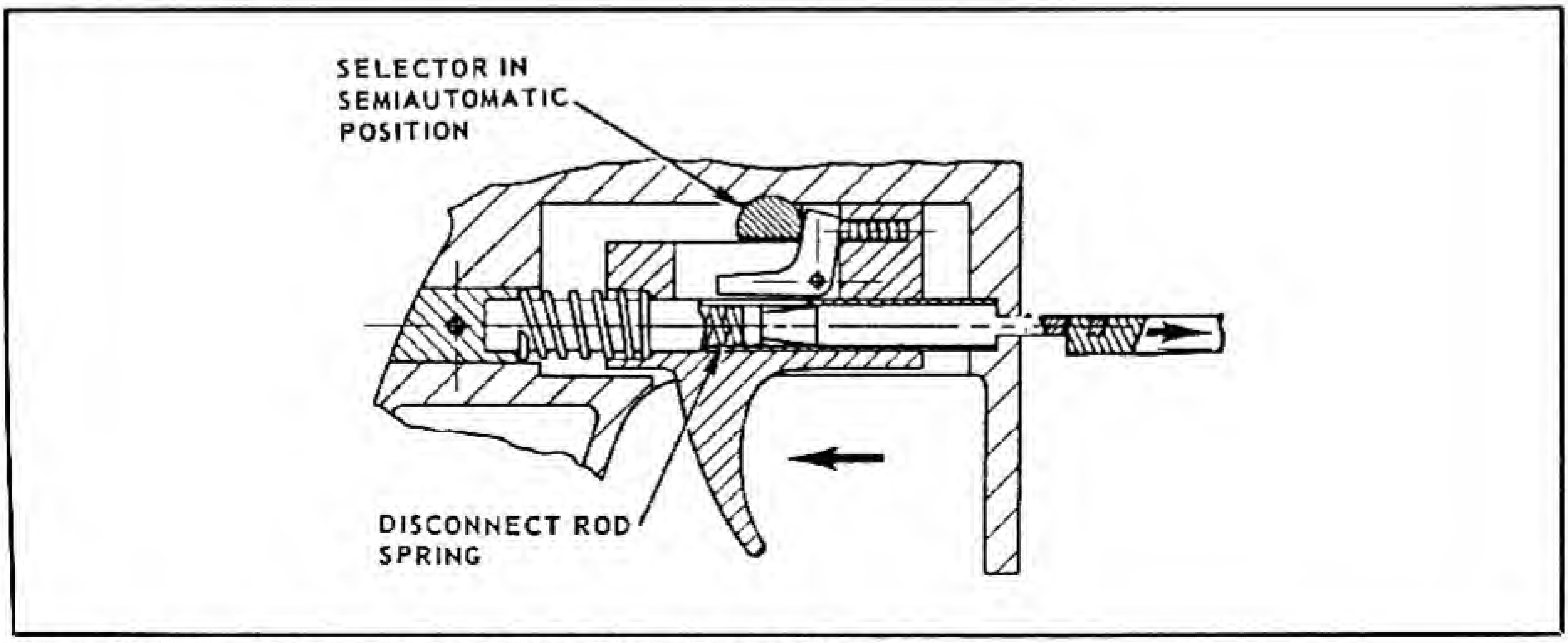
The cartridge in the chamber fires, expelling the projectile and blowing the bolt rearward. The recoiling bolt cocks the hammer via a cam and picks up the


SELECTOR IN AUTOMATIC POSITION
TRIGGER PAWL
PAWL SPRING
TRIGGER GUIDE
DISCONNECT ROD
TRIGGER BAR
TRIGGER SPRING
TRIGGER
GRIP

Trigger Mechanisms Shown Forward with Selector in Automatic Position

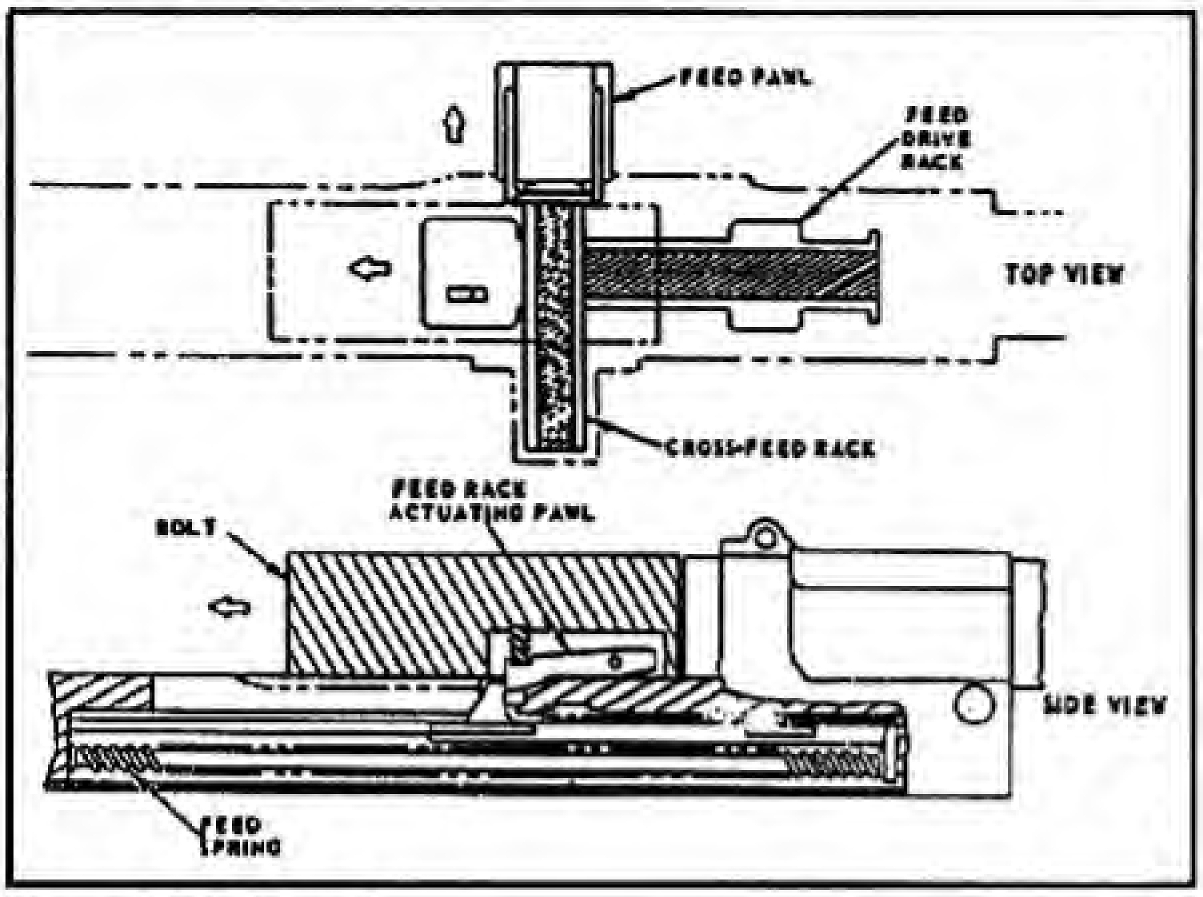


Trigger Mechanism in Automatic Position Shown Firing

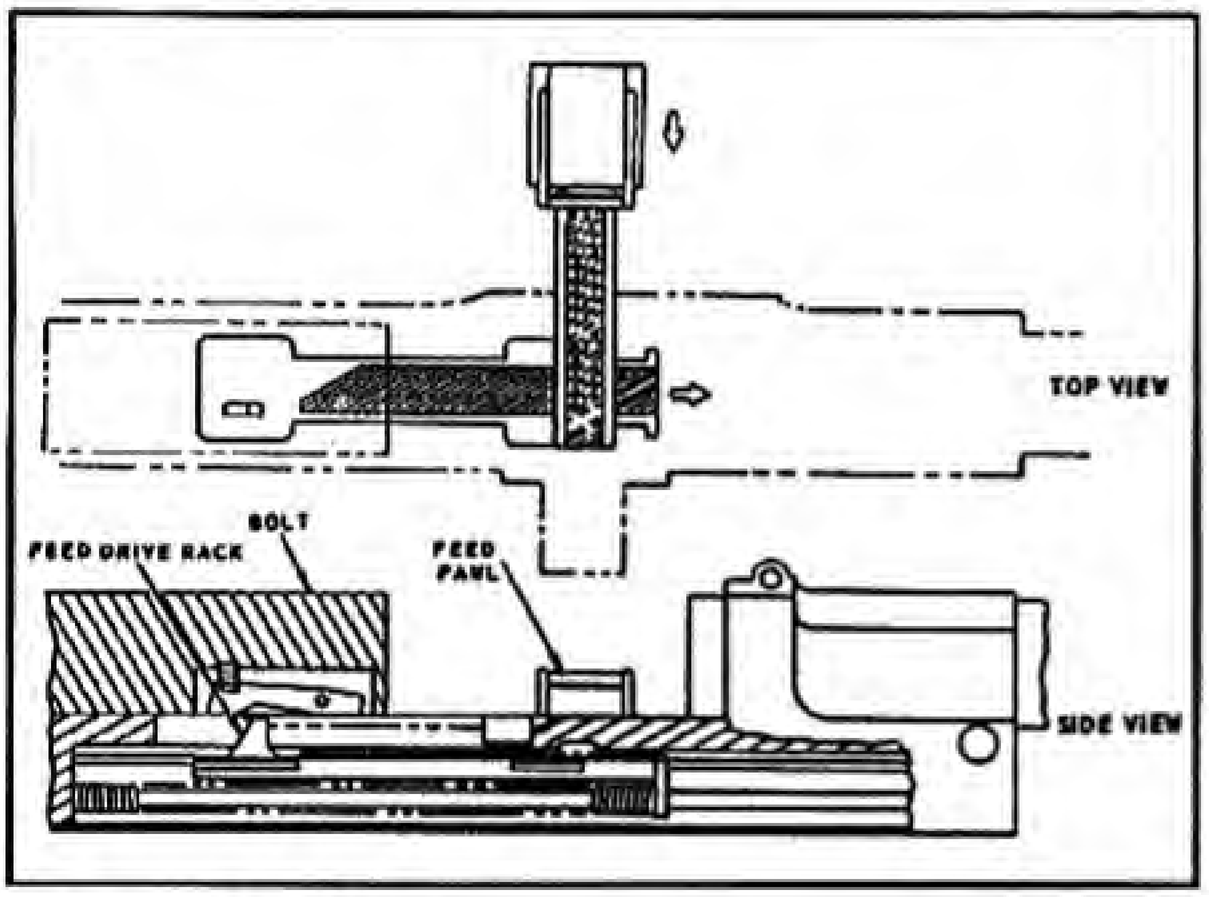

SELECTOR IN SEMIAUTOMATIC POSITION
DISCONNECT ROD SPRING

Trigger Mechanism in Semiautomatic Position Shown Firing a Shot

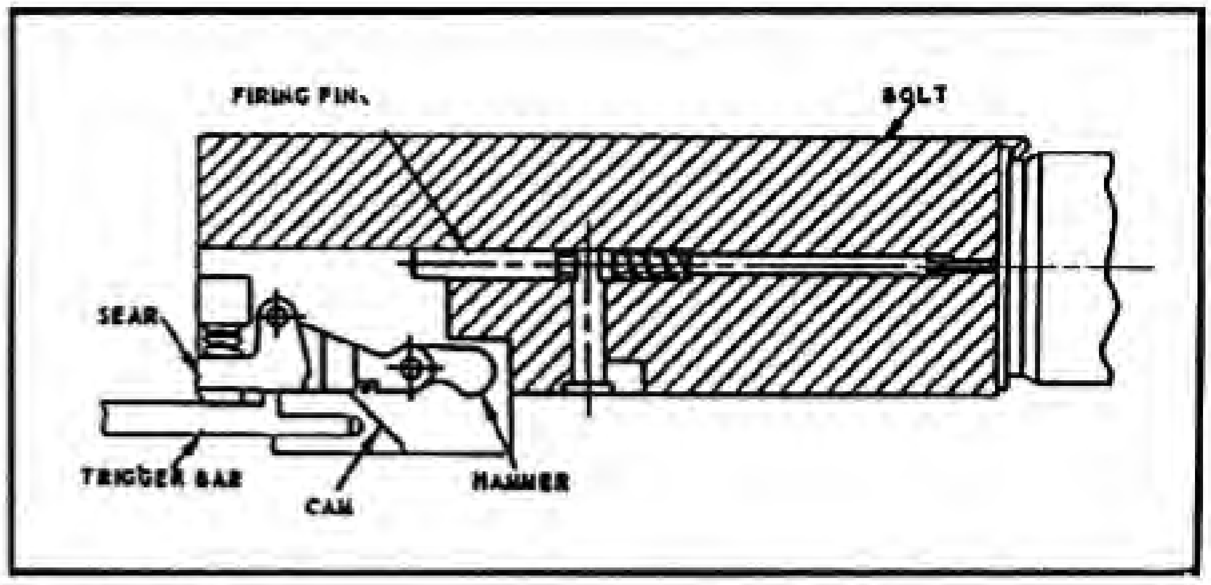
Feed Mechanisms


FEED PAWL
FEED DRIVE RACK
TOP VIEW
CROSS-FEED RACK
FEED RACK ACTUATING PAWL
BOLT
SIDE VIEW
FEED SPRING

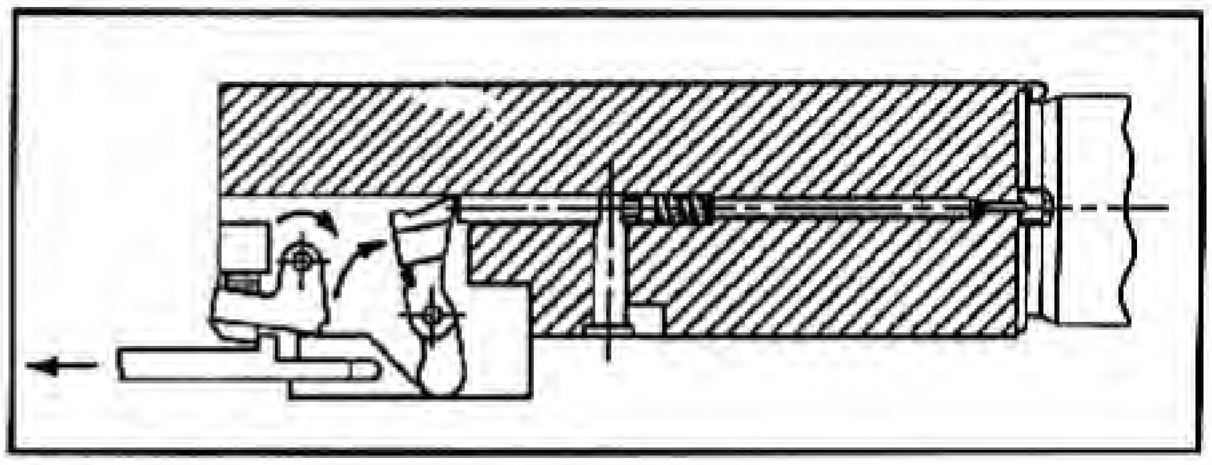
Start of Bolt Recoil


TOP VIEW
BOLT
FEED DRIVE RACK
FEED PAWL
SIDE VIEW

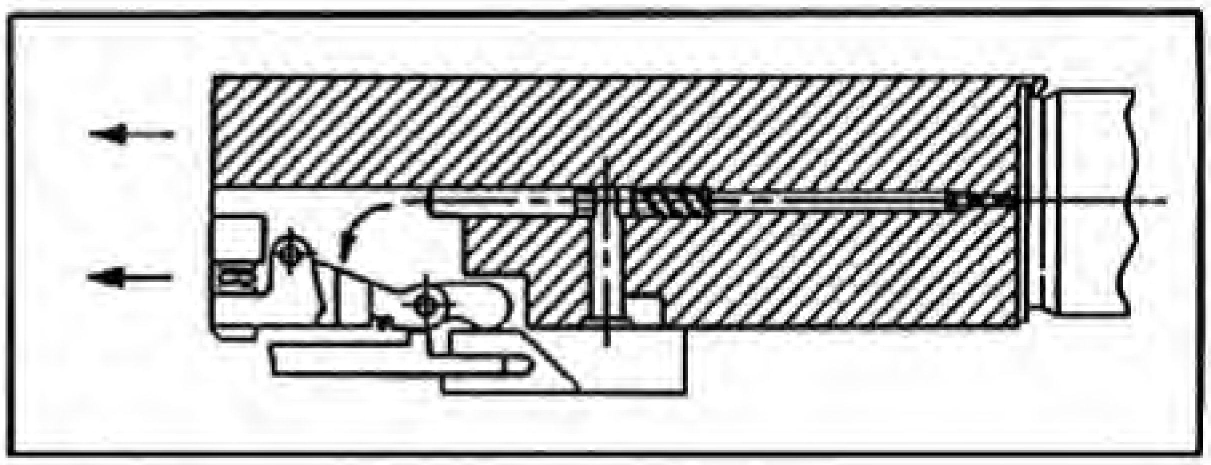
Release of Feed Drive


FIRING PIN
BOLT
SEAR
TRIGGER BAR
CAM
HAMMER

Ready to Fire



Fired



Recoiling

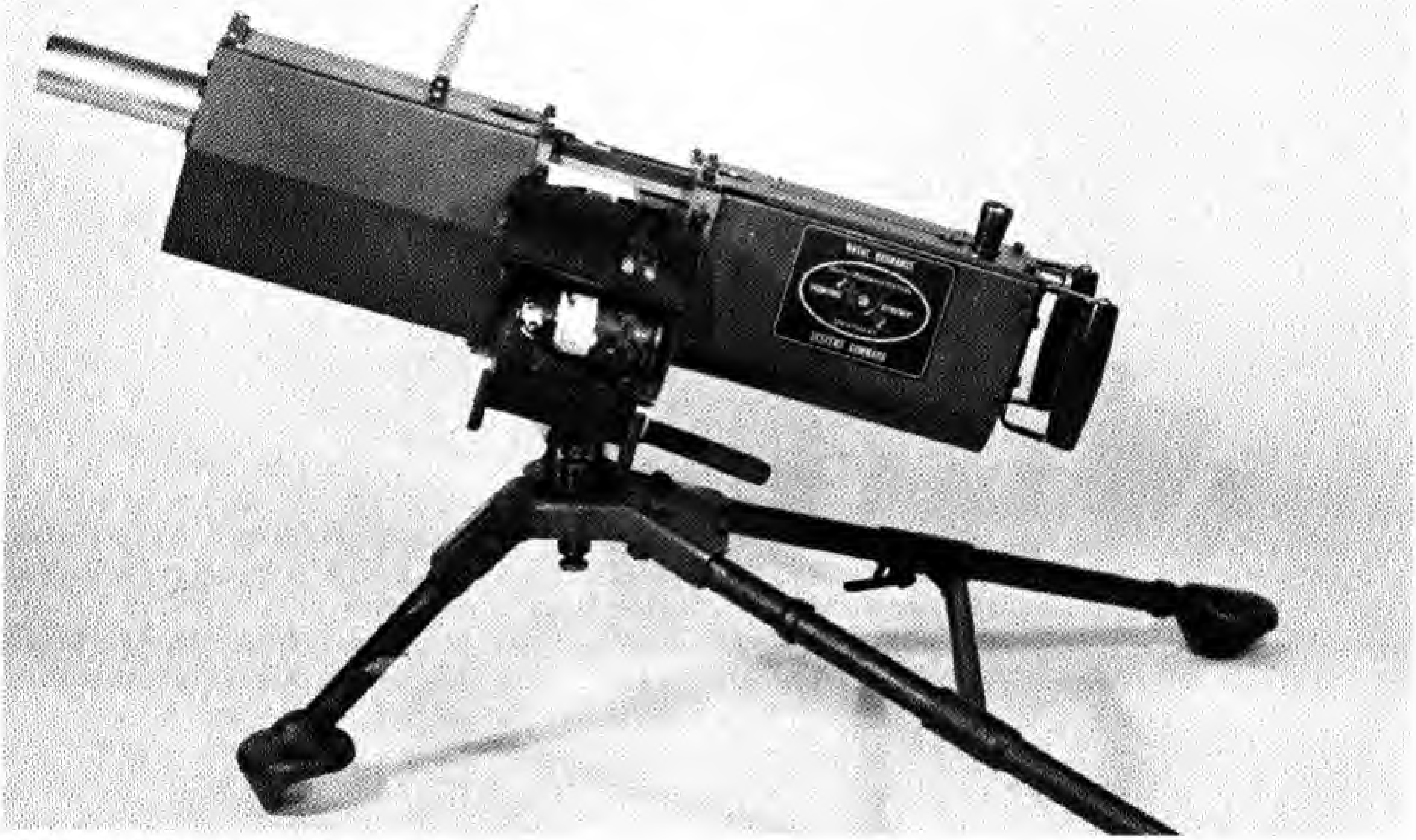
feed drive rack and pulls it rearward. This drives the crossfeed rack to the left, to pick up the next cartridge from the feed tray. The release rod moves to the rear permitting the bolt sear to raise upward in a position to engage the bolt. The ejector rotates inward, ejecting the empty case.

The feed drive rack is released from the bolt and starts to move forward, driven by the feed spring. The bolt continues rearward until it strikes the buffer, which absorbs the recoil energy. The bolt bounces off the buffer and is arrested by the bolt sear. The cross feed rack and the feed pawl return to their rest position, pushing a fresh cartridge into the receiver and pulling the release rod forward to disengage the bolt sear from the bolt. The bolt spring drives the bolt forward, chambering and firing the cartridge. The magazine drive springs rotate the starwheels, pushing a fresh cartridge into the feed tray.

Chapter 63

40mm Mk 20 Mod 0 GRENADE LAUNCHER

NAVAL ORDNANCE STATION LOUISVILLE



Mk 20 Low Velocity 40mm Grenade Launcher

History

In August 1966, Naval Ordnance Station, Louisville, Kentucky, was commissioned by the Naval Ordnance Systems Command and given the task of developing on a maximum effort basis, a 40mm machine gun, fully automatic and semi-automatic, to fire the low velocity 40mm grenade round of ammunition, to be utilized on small river patrol boats. Nine months later, May 1967, the weapon was developed and three prototypes were ready for safety and environmental tests. In May and June 1967, the weapon underwent a series of seven environmental and safety tests. In April and May of 1970, the service certification tests were performed. The tests verified a successful 26 pound weapon, automatic and semi-automatic, that fires low-velocity grenades at a rate of 250 rounds/minute with a range of 400 yards, and required lubrication in only two points every 5000 rounds.

The Mk 20 Mod 0 gun successfully completed the required certification tests and was recommended by NWL for service certification and release to the fleet. Reliability of this gun during the evaluation at NWL was about 265 rounds between stoppages, which is considered good for a weapon of this type. It is significant that all stoppages encountered during the evaluation were minor ones, requiring only a few seconds to clear and ready the gun to resume firing. Since the NWL evaluation, the link used by this weapon has been modified to decrease the round retention force of the link; this has significantly upgraded the weapon's reliability.

After service release of the Mk 20 Machine Gun, units in Vietnam were equipped with it in various applications. It was carried pintle mounted on river patrol craft and land vehicles. User reports indicated high regard for the weapon, because of its capabilities and because of its light weight, simple operation, reliability, and adaptability.

The Mk 20 Machine Gun (Automatic Grenade Launcher) was considered a valuable addition to the Navy's weapon inventory, according to fleet combat reports and NWL Dahlgren.

Purpose

The purpose of this weapon is to provide coverage of targets with high explosive fragmentation grenades.

One of the most useful positions for the weapon is base perimeter defense; its capability to saturate large areas with high velocity warheads makes it very effective against personnel. Because of low recoil loads and the fact that the weapon needs no external power source, the variety of mounting arrangements is large: tripods (M2 and M3) or bipods, vehicular mounts (jeeps, personnel carriers, tanks, boats, etc.) and, if the occasion necessitates, the palm of the hand. The weapon utilizes all of the ammunition designed for the M79 Grenade Launcher.

Cycle of Operation

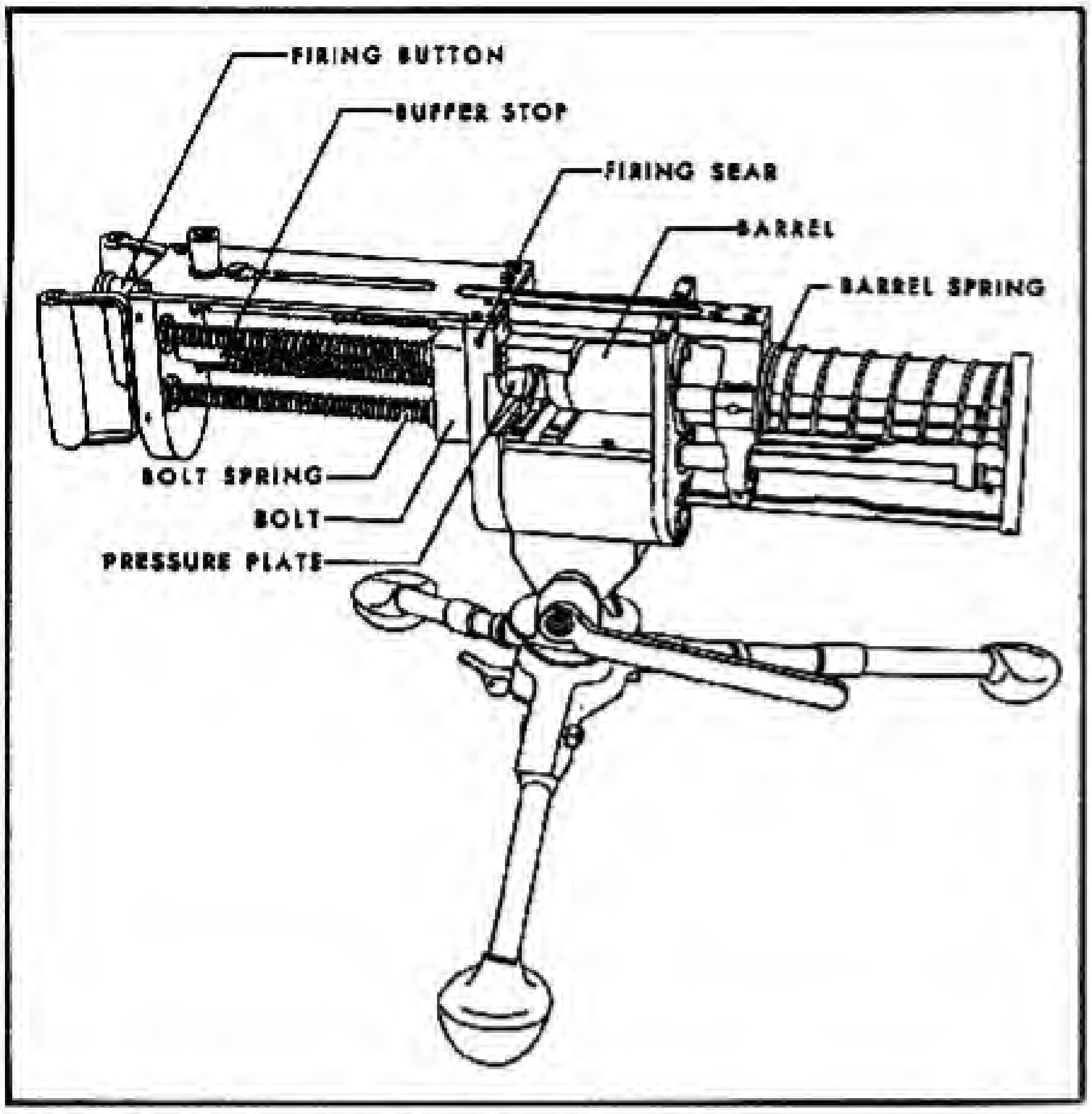
The mechanics of operation are unique because the operation of the weapon does not depend on gas or totally on recoil as do most other weapons rather its operation utilizes horizontally opposed barrel and bolt springs.

The first cartridge is loaded manually into firing position, coming to rest on a spring-loaded pressure plate. When the firing button is pushed, the firing sear releases the barrel and the barrel spring forces the barrel rearward thus actuating a cam that pushes the firing pin into firing position. As the barrel chambers the projectile, the riflings in the barrel jam against the rifling band on the projectile, forcing the cartridge primer into the firing pin located in the bolt, igniting the cartridge primer.

When the cartridge fires, the projectile moves forward, partially compressing the barrel spring by moving the barrel forward; simultaneously, the case is forced into the bolt by thrust, pushing the bolt rearward and compressing the bolt springs. When the bolt approaches the buffer stop, a change of direction occurs and the bolt starts on its forward stroke. When the bolt starts forward, it engages the barrel through a bridge-type arrangement at the top of the weapon, recocking the barrel spring while simultaneously indexing the rotor and the next cartridge into firing position. The empty cases are

Henry Watson, Engineer in Charge of the Mk 20 Program

Colonel George Chinn



Mk 20 in Battery Position, Less Covers

ejected, still linked, during the index operation. This sequence is repeated for both semi and fully automatic firing.

Test Results

Service certification tests, including safety tests, were performed on this weapon at Naval Weapons Laboratory, Dahlgren (NWL Dahlgren) during April and May of 1970. A total of 7,061 rounds were fired from three weapons during the evaluation.

The following operational characteristics of the Mk 20 were measured or determined during the evaluation:

1. Charging Force - 21 lb.
2. Trigger Pull - 18 lb.
3. Belt Pull - 14 lb.
4. Loading Time - 10 sec.
5. Fuze ARming Distance - 55½ ft.
6. Trunnion Force:
   a. Recoil - 200 lb.
   b. Counterrecoil - 300 lb.
7. Maximum Blast Pressure - 0.3 psi (60 decibels)
8. Gun Rate of Fire - 240 rounds/minute
9. Muzzle Velocity - 425 ft/sec

Results of environmental and endurance tests performed on this weapon were as follows:

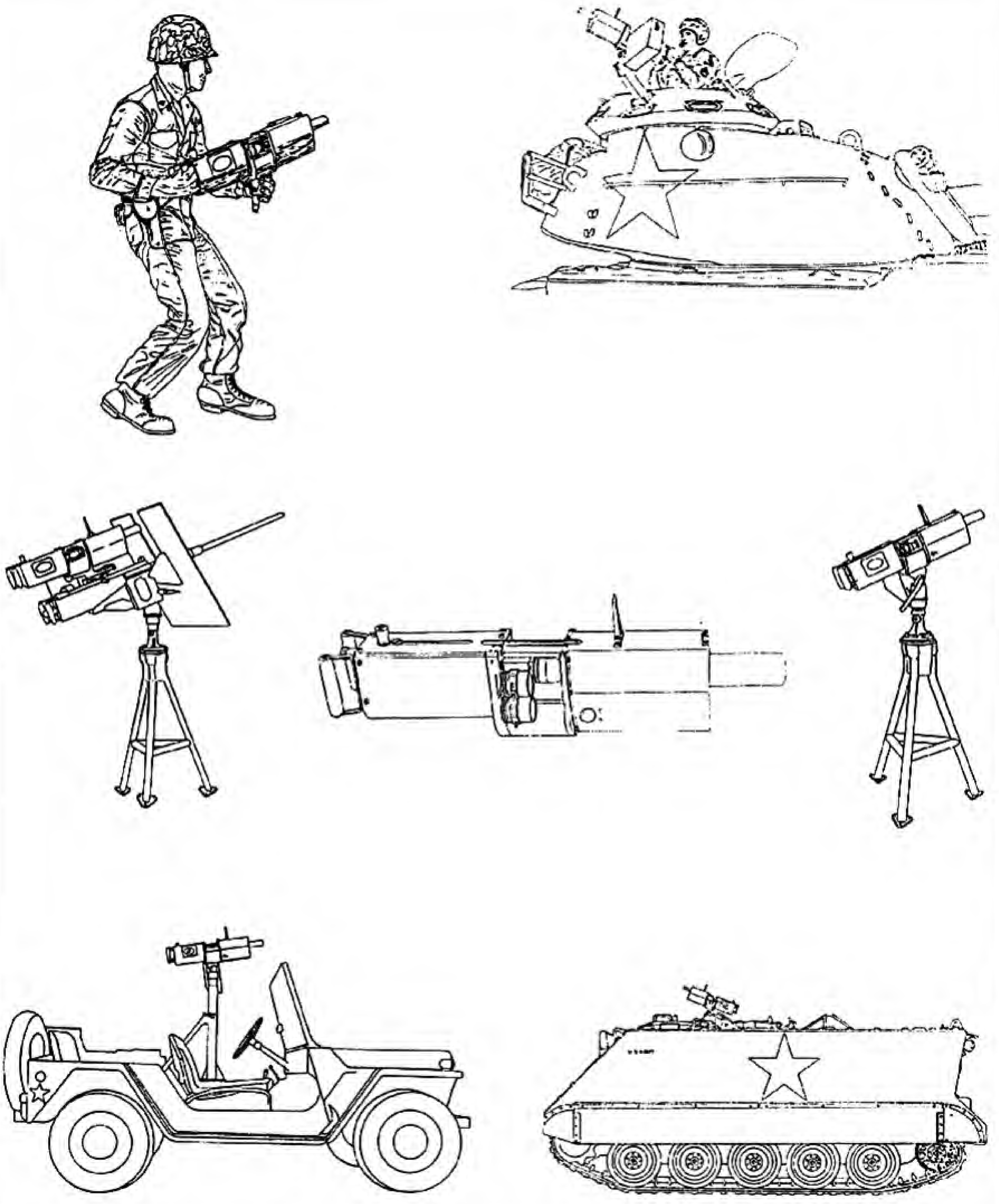
1. Cold Test - The weapon was conditioned to -20°F for two hours and then successfully fired two 20 round bursts.

Characteristics

Bore Size	40mm
Gun Size:	
Length	31.2 inches
Width	9.3 inches
Height	9.6 inches
Weight	26 pounds
Barrel Dimensions:	
Length	13 inches
Muzzle Velocity	240 feet per second
Rate of Fire (Maximum)	425
Trunnion Reactions	300 pounds
Belt Pull	14 pounds
Basic Mechanism	Reciprocating
Number of Barrels	1
Basic System of Operation	Blowback
Power Source of Feeder	Barrel
Type of Feeder	Rotating
Feeder Actuator	Cam
Ammunition Carrier	Link
Method of Chambering	Recoiling
Type of Receiver	Stamped
Type of Firing Mechanism	Percussion
Method of Cooling	Air
Method of Headspace	Fixed
Method of Charging	Manual
Buffing Action:	
Bolt	Spring Loaded
Barrel	Barrel Spring
Source of Design Parameters	U.S. Navy
Designer	Chinn, Schnatter, Watson
Developer	NOS, Louisville
Status of Weapon	Service

2. Hot Test - The weapon was conditioned to +165°F for two hours. Thirty-two rounds were then fired successfully.

3. Environmental tests performed as follows:
   a. Vibration Tests - Weapon successfully fired 40 rounds after completion of vibration tests.
   b. Salt Spray Tests - After salt fog conditioning, the weapon successfully fired the required 500 rounds.
   c. Rain Test - Weapon fired successfully in rain.
   d. Dust Test - The Mk 20 is one of the very few weapons which has passed the dust test. This weapon, after being lubricated, fired all rounds necessary to successfully pass dust conditioning test.



Various Applications of the Mk 20

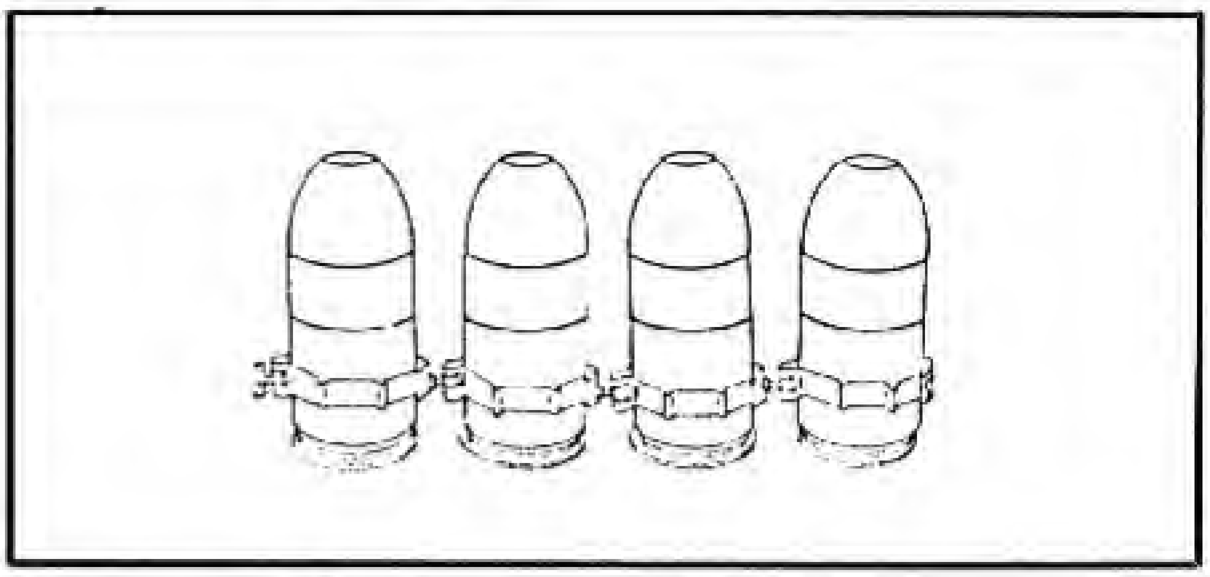
4. Endurance Tests - These tests consisted of firing the weapons in interrupted bursts for a total of 7000 rounds. During these tests parts and springs were observed for wear and set. Velocity and rate of fire data were taken continuously to indicate any adverse effects on the weapons caused by firing many thousand rounds.

Ammunition

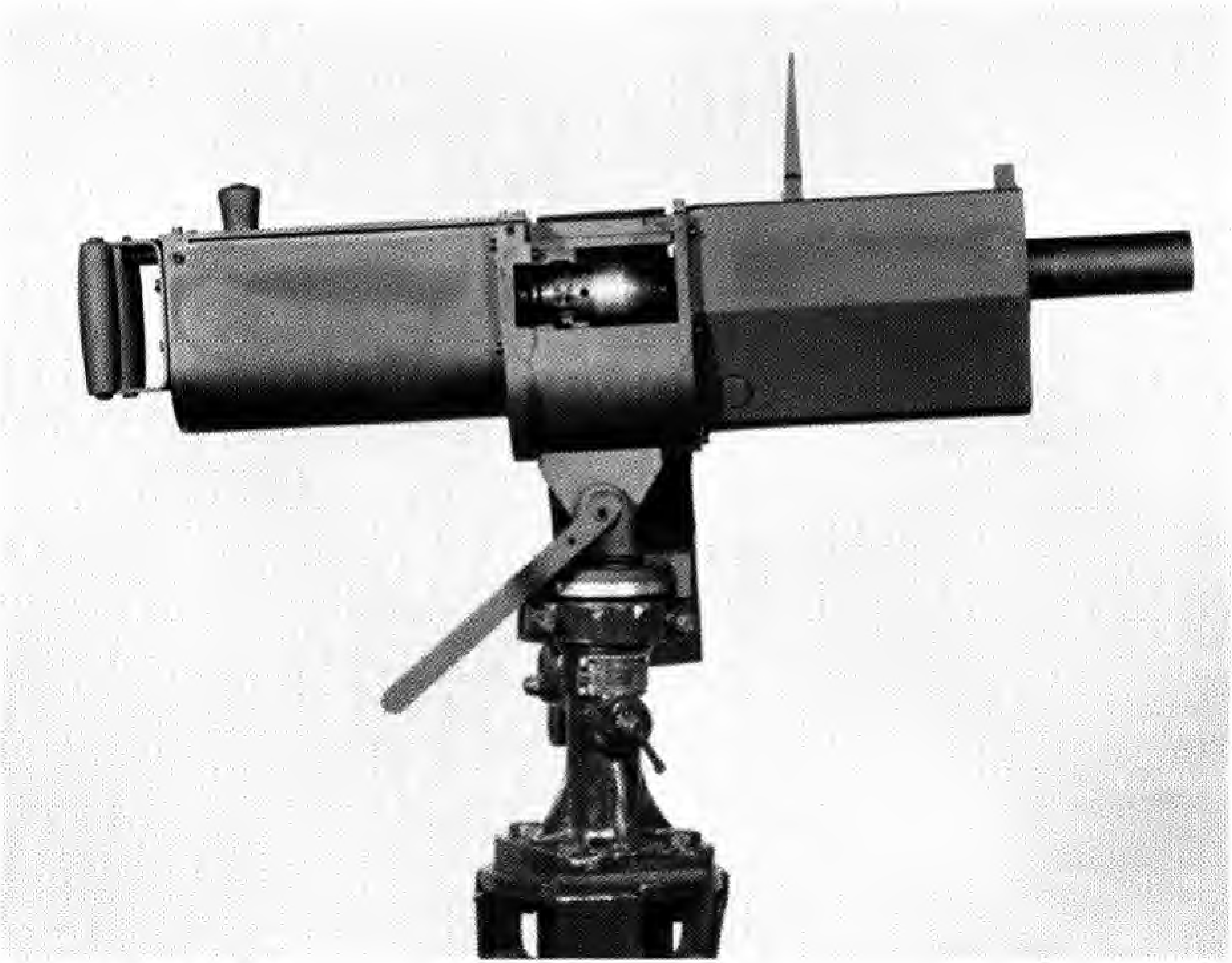
The weapon is capable of firing the following low-velocity ammunition:

M406 Projectile, 40mm, High Explosive
M407-A1 Projectile, 40mm, Practice Smoke
M387 Projectile, 40mm, Practice Inert

The ammunition is belted together in 24 round lengths utilizing the standard Army M16 40mm Link.



Ammunition Cartridges

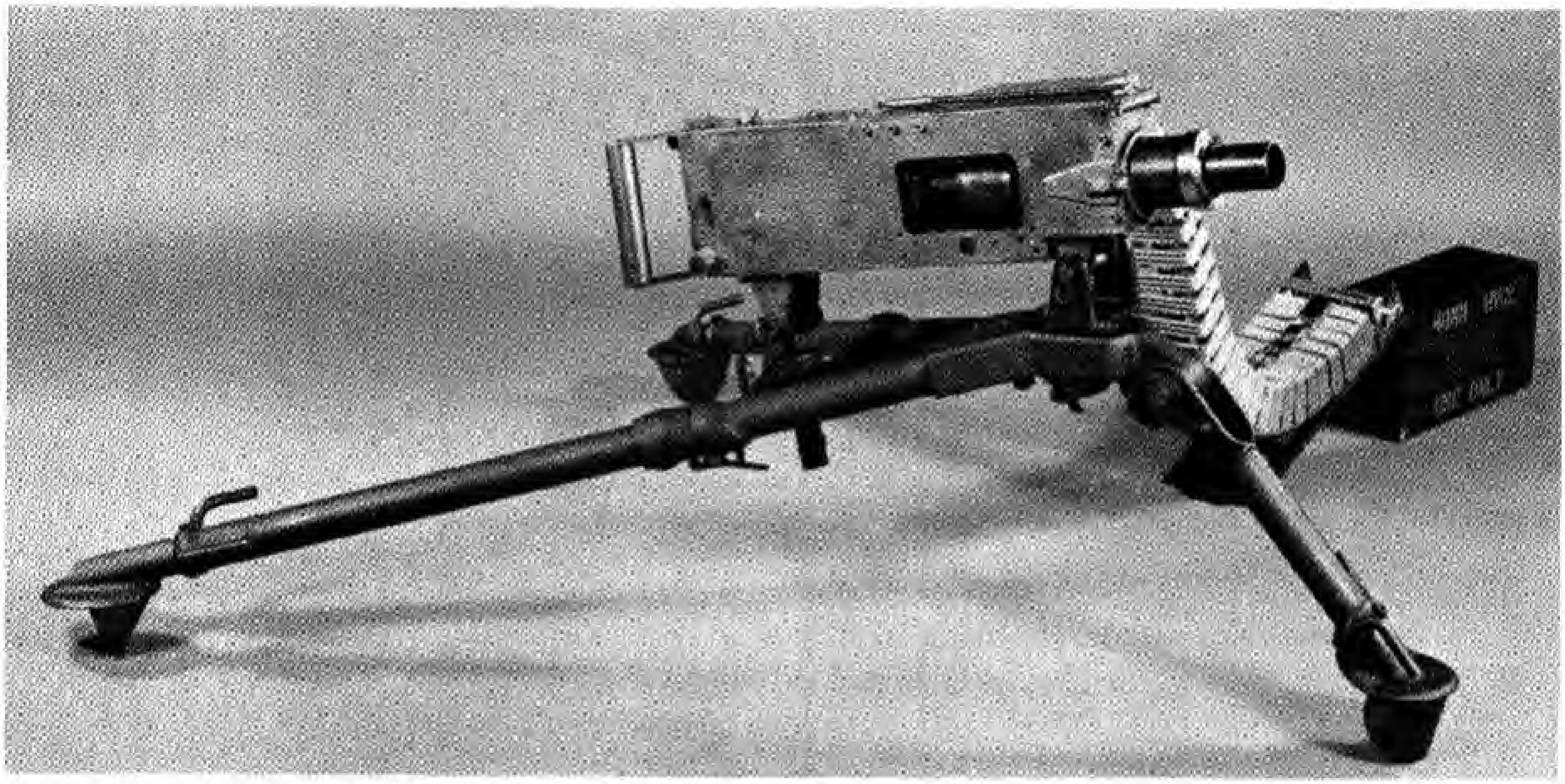


Mk 20 with Grenade in Place

Chapter 64

40mm GRENADE LAUNCHER (CROW)

PHILCO-FORD CORPORATION



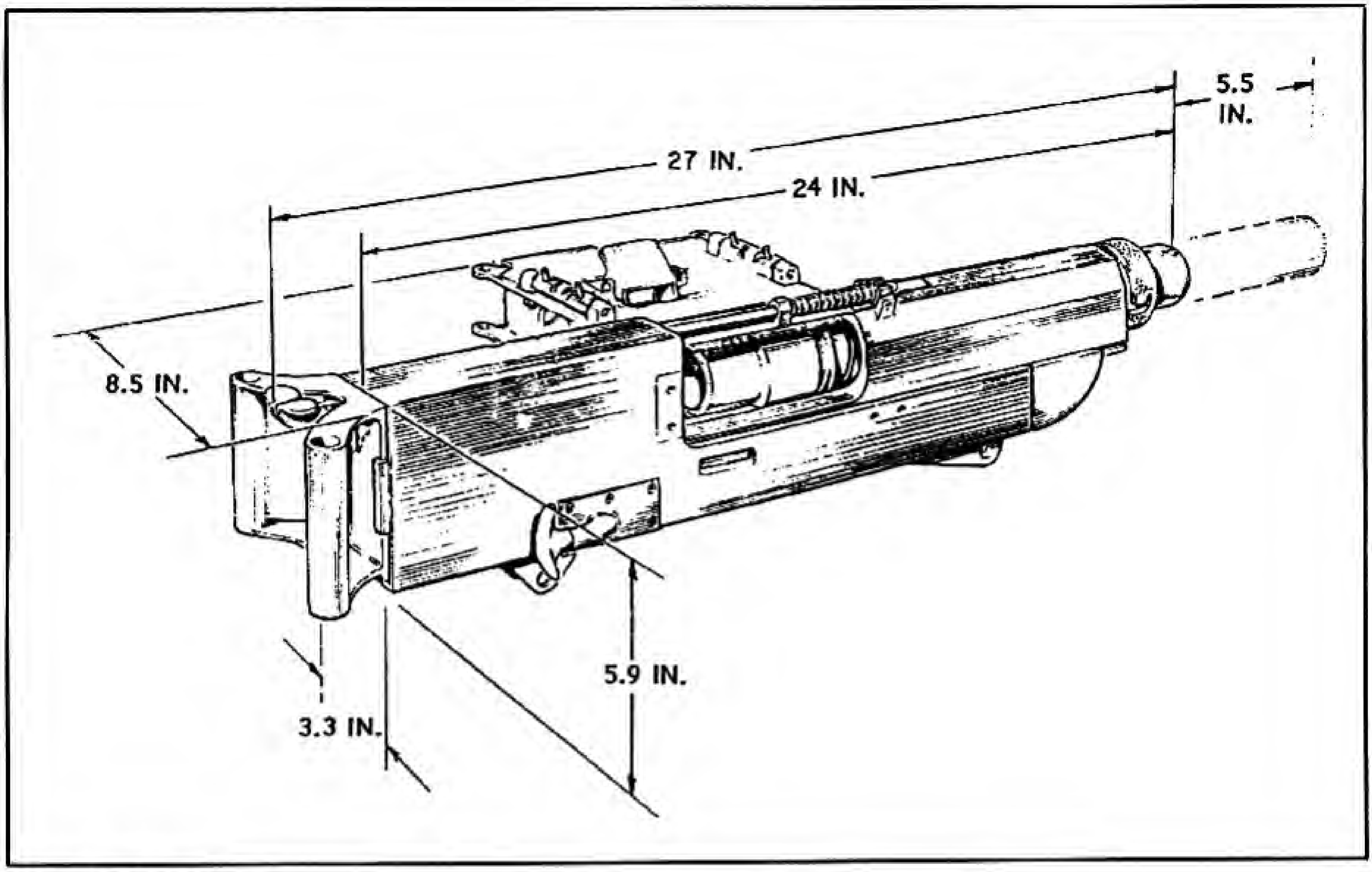
40mm Grenade Launcher CROW

History

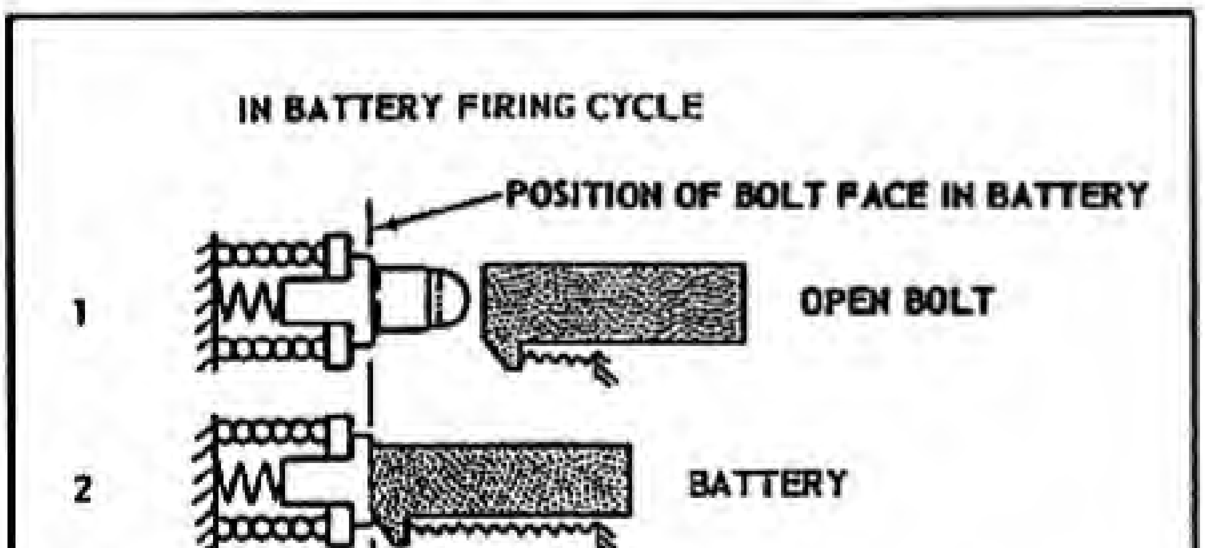
In early 1969 Aeronutronic Division of Philco-Ford proposed a weapon concept utilizing counter-recoil operation which would meet Army requirements and offer advantages over similar inventory or development weapons. This concept was directed towards the 40mm automatic grenade launcher on the basis that a proposed Qualitative Material Requirement was being reviewed for Army calendar year 1975 requirements and because inventory ammunition would be immediately available for the development of the weapon.

The concept was developed under an Independent Research and Development program in which a 40mm firing fixture was designed and fabricated. This fixture was shown to the Weapons Command and other cognizant government agencies in September 1969, at which time 50 round bursts in both a continuous and sporadic firing cycle were demonstrated. Selectable rate of fire feature which permits the weapon rate to be adjusted, consistent with the specific application from 120 to 400 rounds per minute were also included in the demonstration.

Concurrent with the IR&D demonstration, Philco-Ford submitted a proposal for the design and study of the 40mm automatic grenade launcher incorporating the features of the CounterRecoil Operated Weapon (CROW) principles. The contract was later awarded for the engineering design analysis necessary to assure that the 40mm counterrecoil operated weapon


27 IN.
24 IN.
5.5 IN.
8.5 IN.
5.9 IN.
3.3 IN.

40mm CROW Weapon


IN BATTERY FIRING CYCLE
POSITION OF BOLT FACE IN BATTERY
1
OPEN BOLT
2
BATTERY
3
FIRE AND RECOIL
4
COUNTERRECOIL
FEED DRIVE
5
OPEN BARREL
BOLT
6
FEED AND EJECT

40mm CROW Operating Cycle

could proceed to fabrication and development.

Description and Purpose

Philco-Ford's 40mm CROW was designed to provide a tripod mounted fully automatic machine gun for the 40mm High Velocity Grenade cartridge series (M384 and M385) and the M16A1 link.

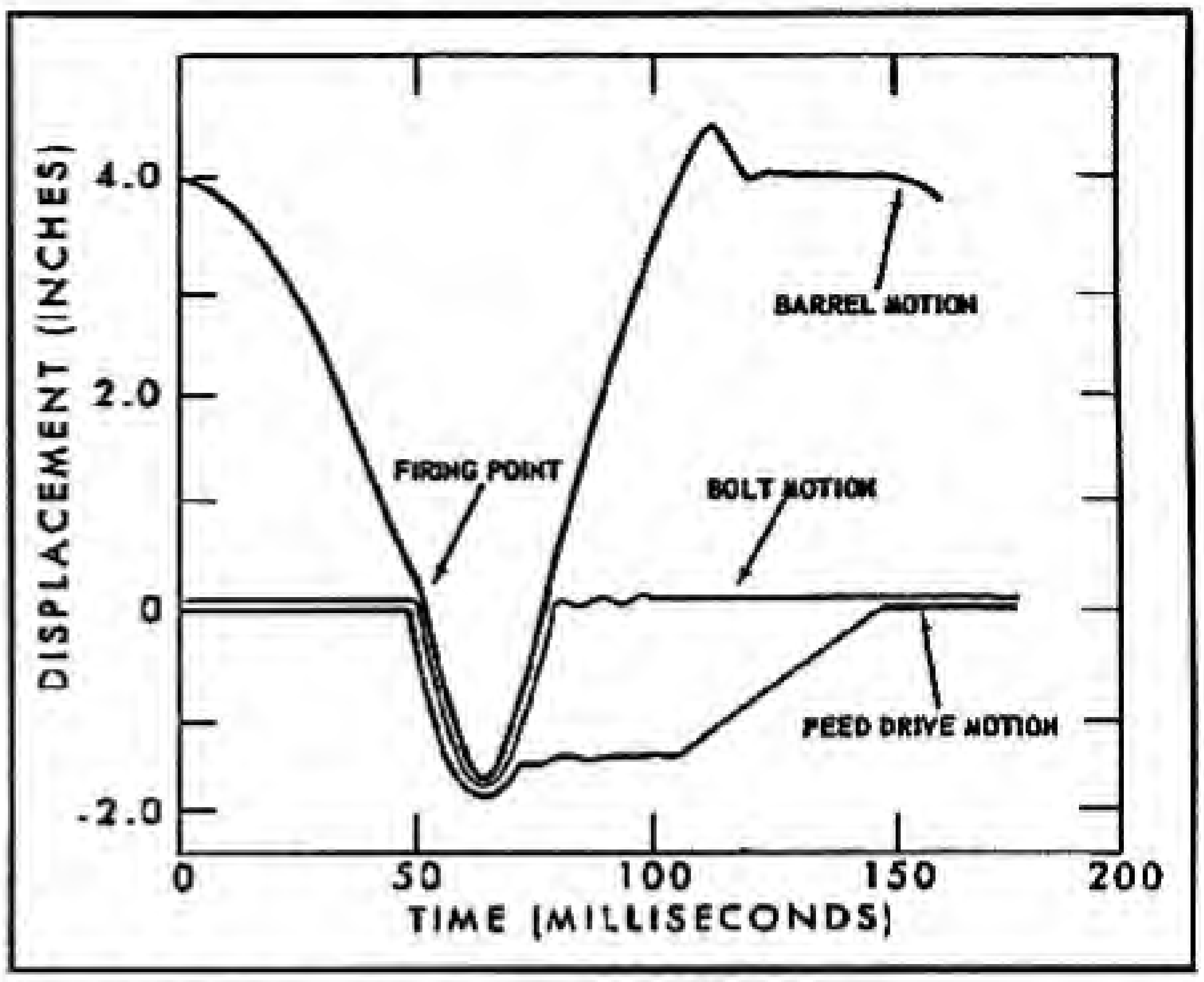
The final design was 27 inches long, 5.9 inches high, and 8.5 inches wide including the feeder. Weight was about 35 pounds. Trunnion load was under 1,500 pounds, the rate of fire was selectable (140, 270 or 400 rounds per minute) and it could be configured for either left or right hand feed. Charging was manual for this air cooled weapon. Belt pull was at least 50 pounds.

Cycle of Operation

The counterrecoil operated weapon operates on the principle of converting the kinematic energy of the round into potential energy. This energy stored in various springs is released during the counterrecoil stroke to open the barrel, eject the spent round and feed the next round.

Characteristics

Bore Size	40mm
Rate of Fire	150, 250 or 400 rpm (selectable)
Basic Systems of Operation	Externally Powered
Cooling System	Air
Method of Charging	Manual
Link	M16A1 Mechanical Linkage
Type of Receiver	Stamped
Manufacturer	Philco-Ford
Ammunition	384/385
Type	HE-HEI-Smoke, AP
Overall:	
Length	27 in.
Width	8.5 in. w/feeder
Height	5.9 in.
Weight	35 lb.



Time-Displacement of 40mm CROW

The firing mechanism utilizes three major components and their associated drive springs.

The weapon is manually charged, this operation opens the barrel, compressing the barrel spring, and advances the feed system to position a round in battery.

The trigger is then depressed releasing the barrel which is driven closed by the barrel spring that was compressed during the charging operation. As the barrel closes, it delinks and strips the link back and cocks the firing mechanism.

The barrel locks to the receiver and the weapon fires. The barrel, receiver and bolt recoil together. During this phase the projectile travels through the barrel, exits and complete blowdown of barrel pressure occurs.

The feed drive receiver and its spring are seared at a position approximately 1.5 inches aft of battery. The barrel and bolt are driven forward by the bolt spring.

The bolt stops when it reaches the battery position. The barrel lock is released which permits the counterrecoil momentum of the barrel to drive the barrel forward. After the barrel has traveled forward a predetermined distance, the feed drive receiver begins moving and advances the feed pawl which feeds the next round, displacing and ejecting the spent case.

Upon completion of feed, the barrel sear is automatically released initiating the next firing cycle. This procedure continues until the trigger is released locking the barrel sear and restraining the barrel in the open position.

The weapon rate of fire is controlled by a hydraulic damper which permits adjustment of the feed phase time. The remainder of the weapon cycle is unchanged regardless of the firing rate.

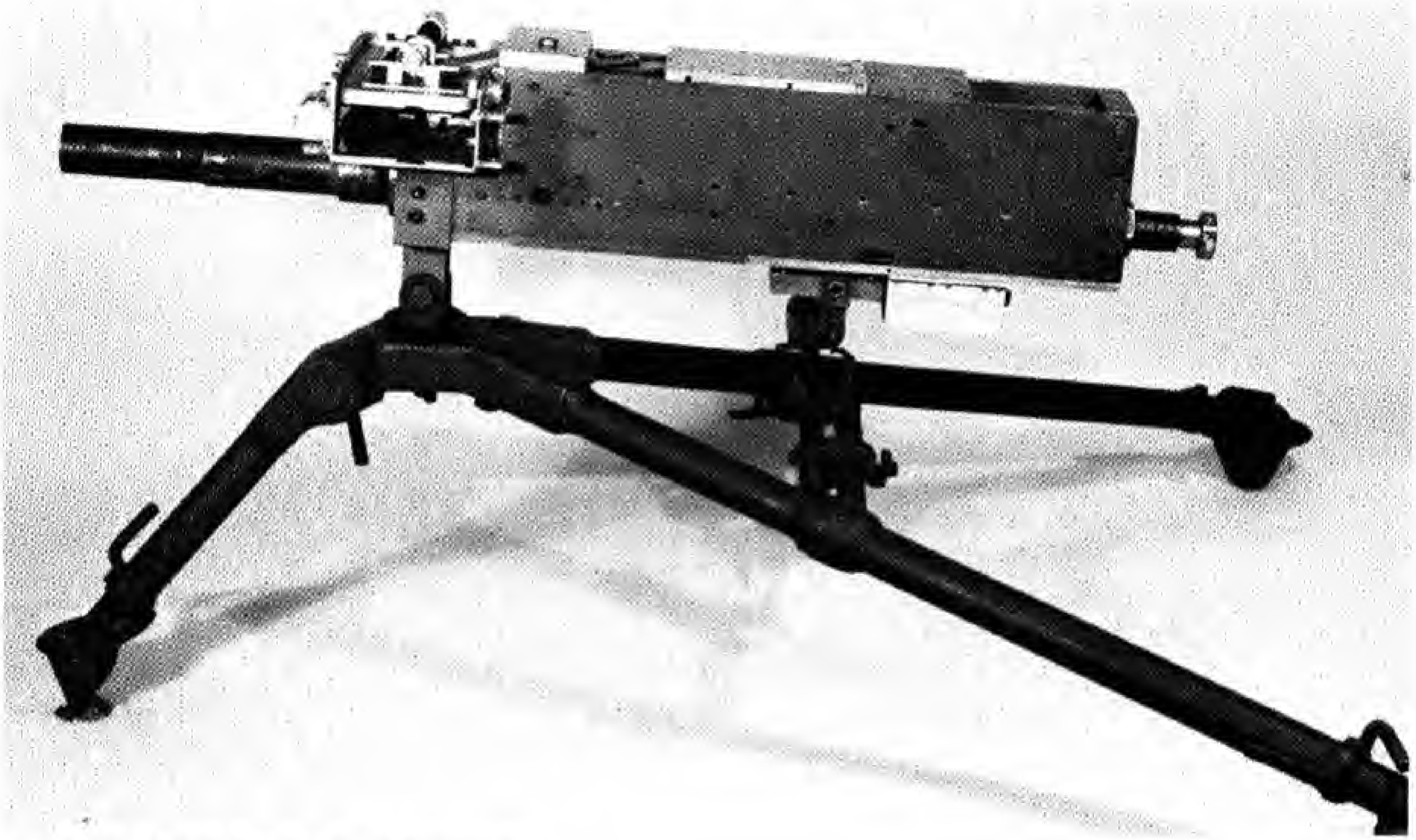
Of particular importance in this 40mm design are the requirements of the weapon:

(a) Fire the existing 384/385 family of ammunition
(b) Use the existing standard M16A1 link assembly
(c) Interface with standard ammunition chuting
(d) Offer trunnion loads of 1500 pounds or less
(e) Offer right or left hand feed
(f) Weigh 35 pounds or less
(g) Offer selectable rate of fire
(h) Minimize number of parts

The significance in this program was its utilization of inventory ammunition, thus eliminating costly ammunition development which is typically associated with the development and the deployment of a new weapon.

Chapter 65

40mm Mk 19 GRENADE LAUNCHER
NAVAL ORDNANCE STATION LOUISVILLE



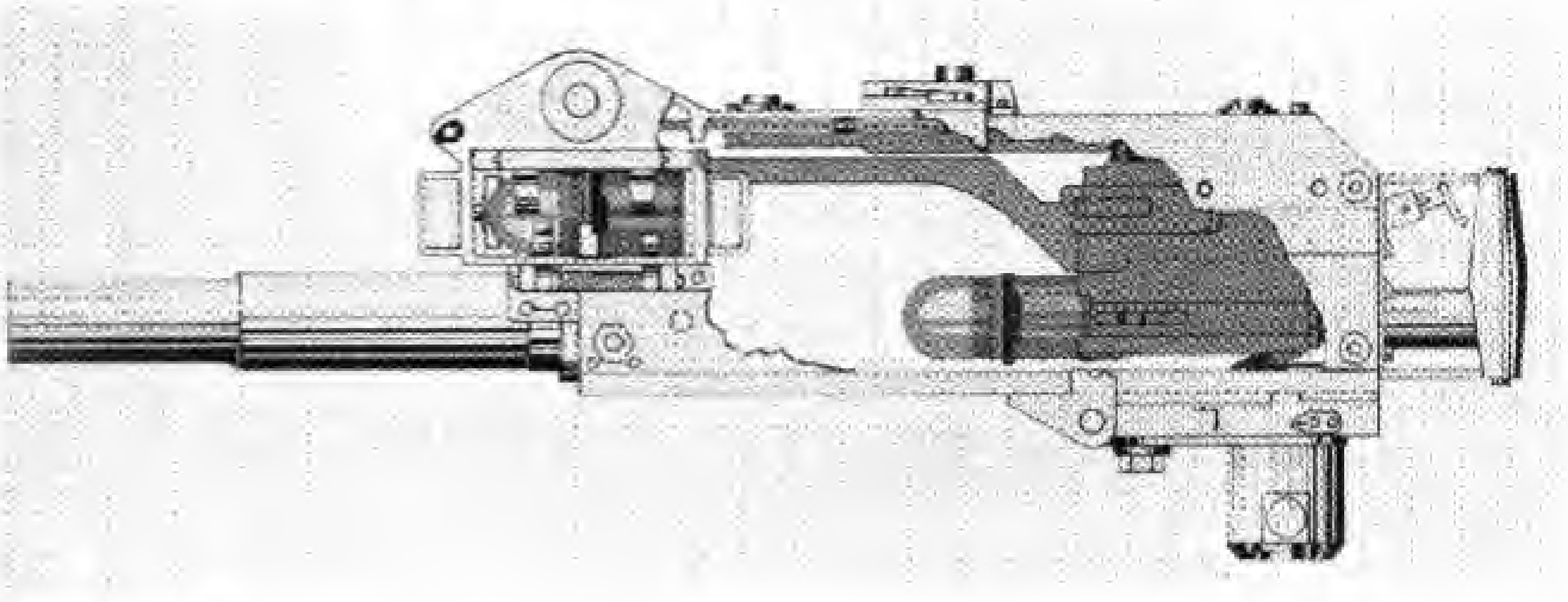
40mm Mk 19 High Velocity Grenade Launcher

History

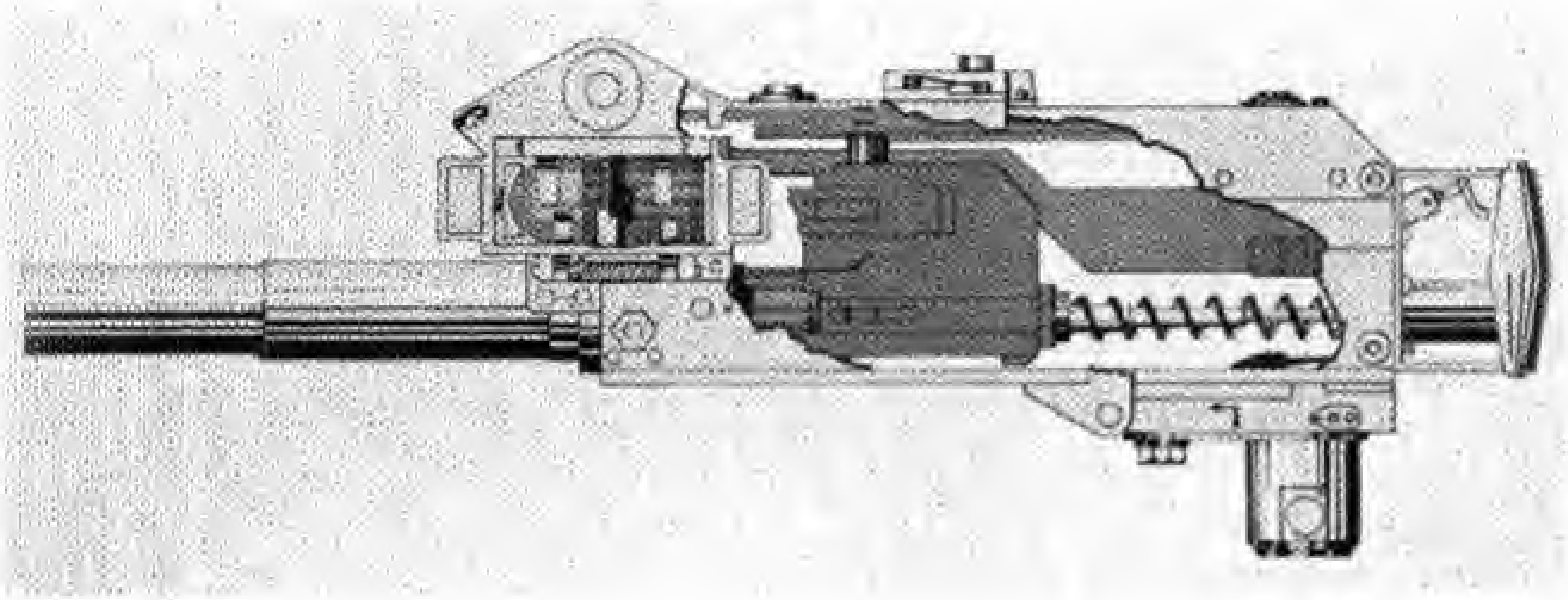
Because of the immediate need, pilot production of the Mk 19 Mod 0 was by-passed by going directly from development to production. Shortcomings known to exist prior to and during production, and obtained from fleet feedback, resulted in the Naval Ordnance Station at Louisville proposal to correct these known shortcomings through redesign of the Mk 19 Mod 0. Initial approval of the Mk 19 Mod 1 design and development effort was given to Naval Ordnance Station at Louisville by Naval Ordnance Systems Command in August 1969. Safety and reliability difficulties experienced with the weapon in the Mod 0 version were completely eliminated by design change in the Mod 1 gun.

Purpose

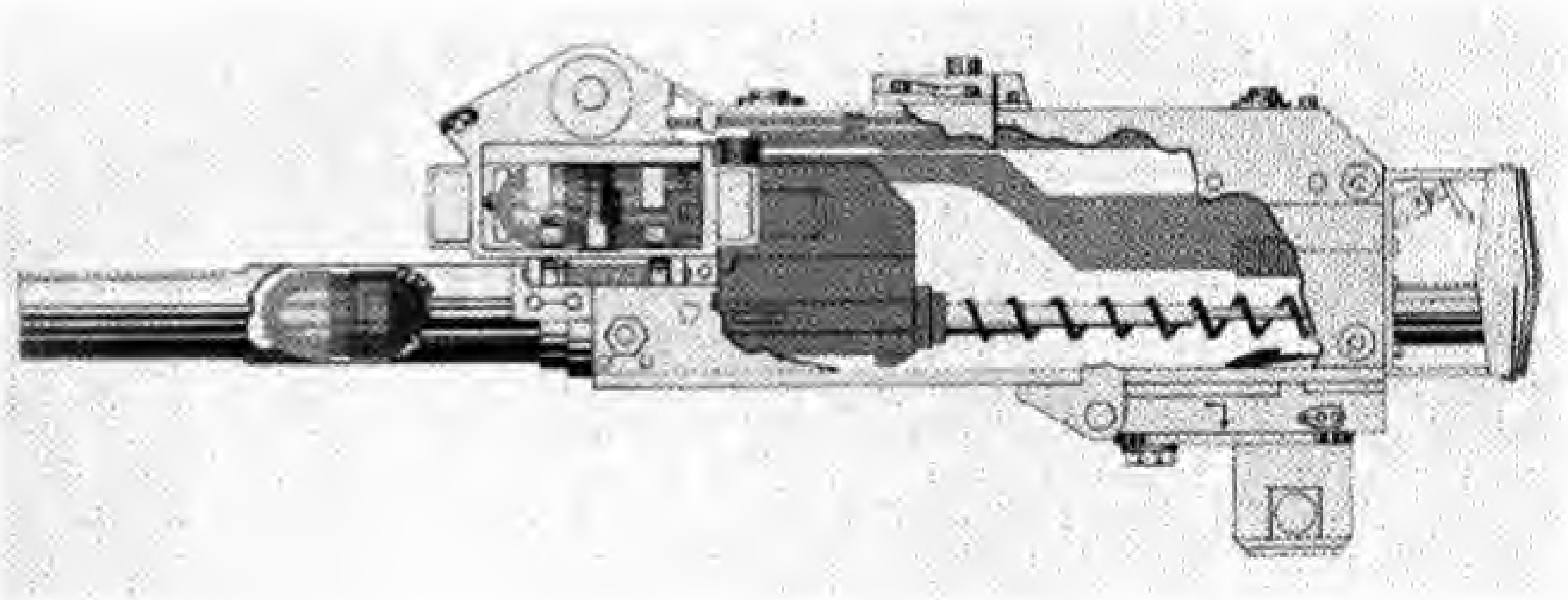
This weapon provides area coverage of targets at ranges up to 2200 meters with high explosie fragmentation warheads, and is also an excellent perimeter defense weapon. Designed for use on small boats, it is hand or solenoid fired and utilizes a unique form of



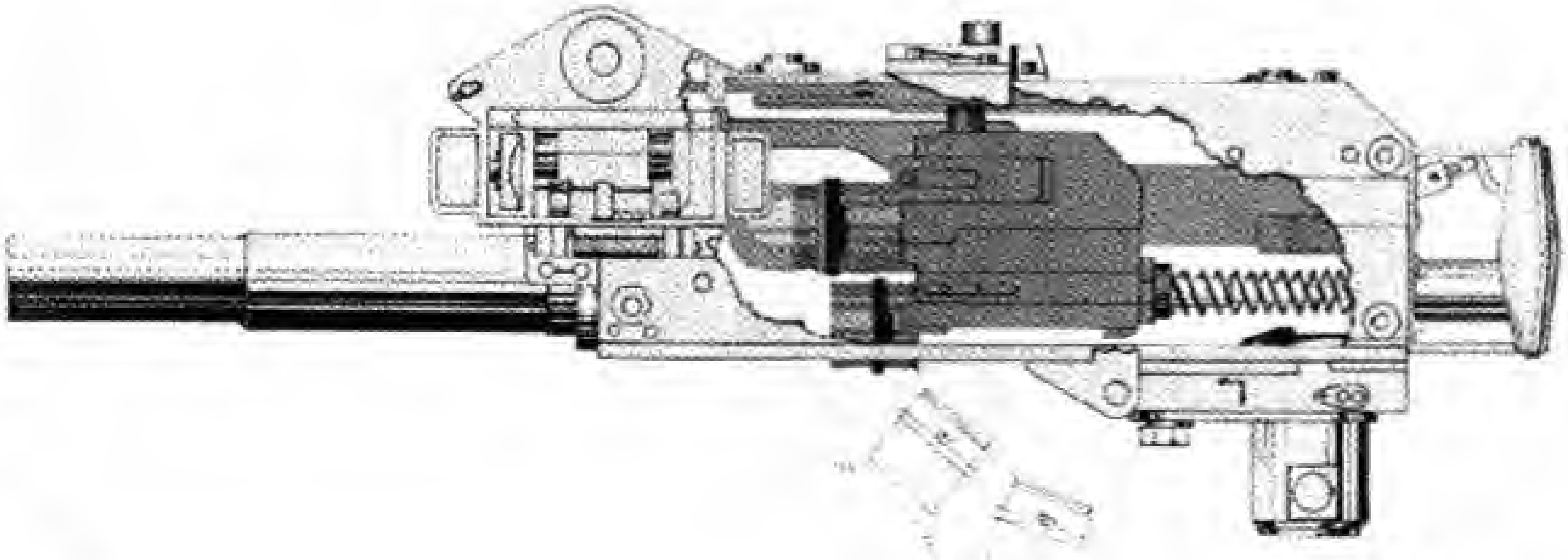
Sear Position



Forward Travel



Firing



Recoil

Mod 1 Characteristics

Calibre	40mm
Weight	46 lbs.
Length	32 ins.
Width	8.5 ins.
Height	7.5 ins.
Mode of Fire	Full or Semiautomatic
Direction of Feed	Left to right
Type of Feed	Mechanical (M16 link)
Rate of Fire	450-500 rpm
Maximum Range	240.59 yds.
Effective Range	174.97 yds.
Muzzle Velocity	800 fps
Barrel Twist	Right hand, one turn in 48 ins.
Barrel Length	12 ins.
Method of Operation	Advanced primer ignition
Cooling	Air
Firing Cycle	Starts from open bolt
Method of Charging	Manual (right or left hand)
Charging force	75 lb.
Trigger pull	40 lb.
Belt pull	20 lb.
Loading time	15 sec.
Fuze arming distance	75 ft.
Trunnion force (recoil)	1500 lb.
Maximum blast pressure	9.9 psi

blowback operation known as advanced primer ignition.

Cycle of Operation

To load the Mk 19 Mod 1 Machine Gun, the feeder cover is opened and the flexible feed chute positioned in place. The linked rounds are fed from the ammunition can through the flexible-feed chute and the gun feeder until the first round is seated against its back stop. The bottom pawls must be in the up position. The bolt is pushed forward until the extractors snap over the rim of the round against the back stop. The cover is then closed.

The bolt is pulled to the rear until it engages the trigger sear. The safety lever is pushed to the horizontal position placing the weapon on "SAFE."

When the safety lever is in the vertical position, the gun is on "FIRE." Either the hand trigger or the solenoid will release the sear and allow the bolt to go forward into battery.

With the cover group raised and the bolt seared to the rear, the first round in the belt is placed in position in the round stop pawls. Closing the cover group and triggering the bolt off of its sear permits pick-up jaws to engage rim of the first round. Pulling the bolt to the rear delivers the first round, cocks the firing pin, indexes the round down the vertical cam its battery position and leaves the bolt on sear ready to fire. The second round is indexed into pickup position by the horizontal cam, rocker arm, and feeder shuttle.

The released sear permits the drive springs to push the bolt forward into battery firing the round with the link pushed back approximately 3/4" from the base of the cartridge. At the same time the mass of the counterrecoiling bolt is cushioned by both of the explosion of the propellant charge that also starts another entire cycle of operation to repeat itself.

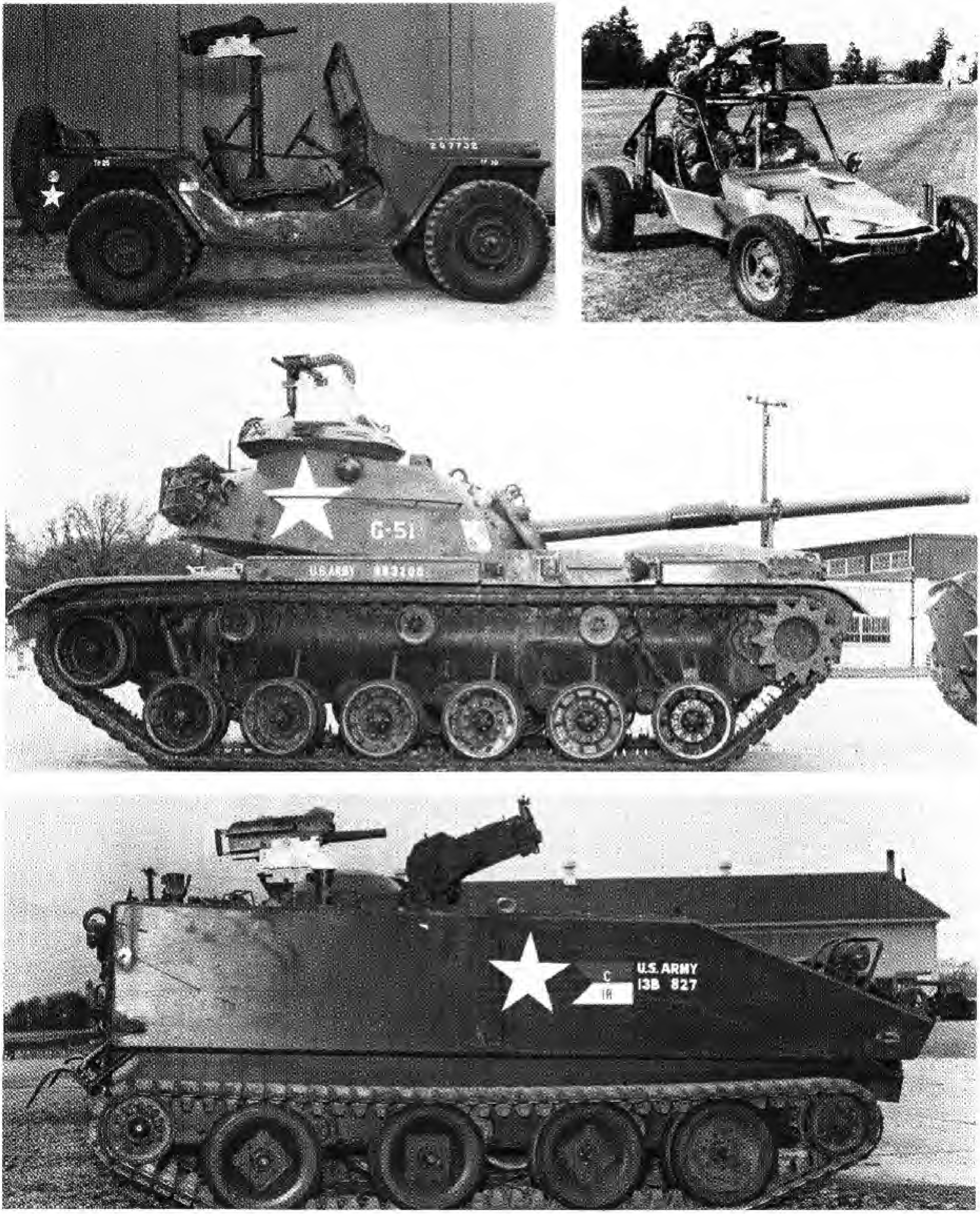
Test Results

Service certification tests were performed on this weapon intermittently in 1969, 1970, and 1971. The first version of this weapon was the Mk 19 Mod 0 for which basic design feasibility was demonstrated; however, there were safety and reliability difficulties associated with the operation of the Mk 19 Mod 0. Accordingly several improvements were incorporated and the weapon was redesignated the Mk 19 Mod 1. In this configuration the weapon successfully completed service certification tests and was issued for use by combat units in Vietnam.

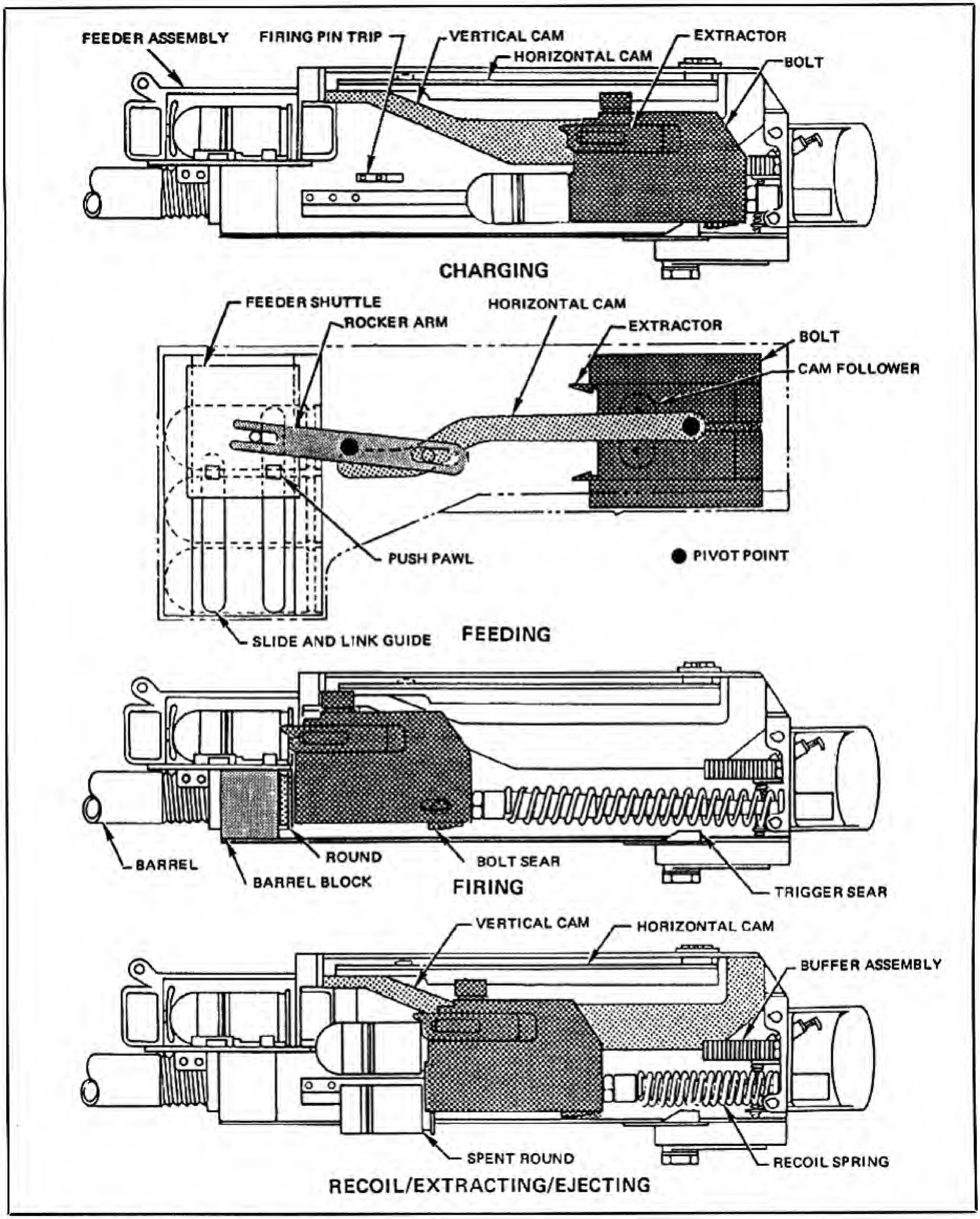
The operational characteristics of the Mk 19 were measured or determined during the evaluation.

Results of environmental and endurance tests performed on this weapon were as follows:

1. Cold Test - The weapon was conditioned to -65°F and successfully fired.
2. Hot Test - The weapon was conditioned to +165°F and successfully fired.
3. Environmental tests in accordance with MIL-STD-810B as follows:
    a. Vibration Test - Weapon successfully fired after vibration conditioning.
    b. Salt Spray and Rain Test - Successfully fired after conditioning.
    c. Dust Test - Weapon failed to complete the dust test.
4. Endurance Tests - These firings included a wide variety of tests conducted on the Mk 19 during various stages of its development. Most of the endurance firing was conducted using weapons in the Mod 1 configuration. Approximately 14,000 total rounds have been fired at NWL in the Mk 19 grenade launcher. The Mod 1 version proved to be a safe, reliable, effective weapon.


G-51
U.S. ARMY
13B 827

40mm Mk 19 in use on a Variety of Military Vehicles



CHARGING

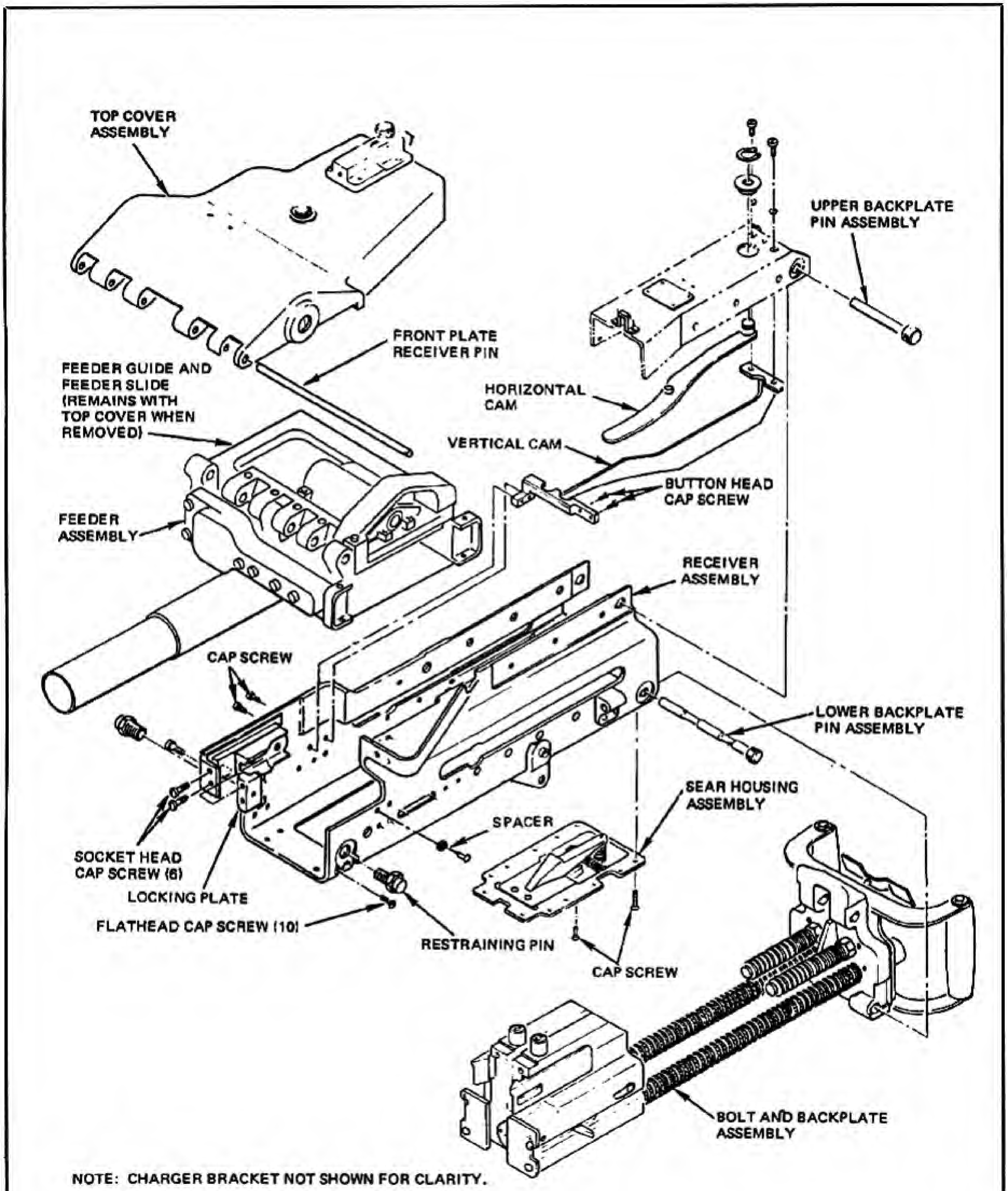
FEEDING

FIRING

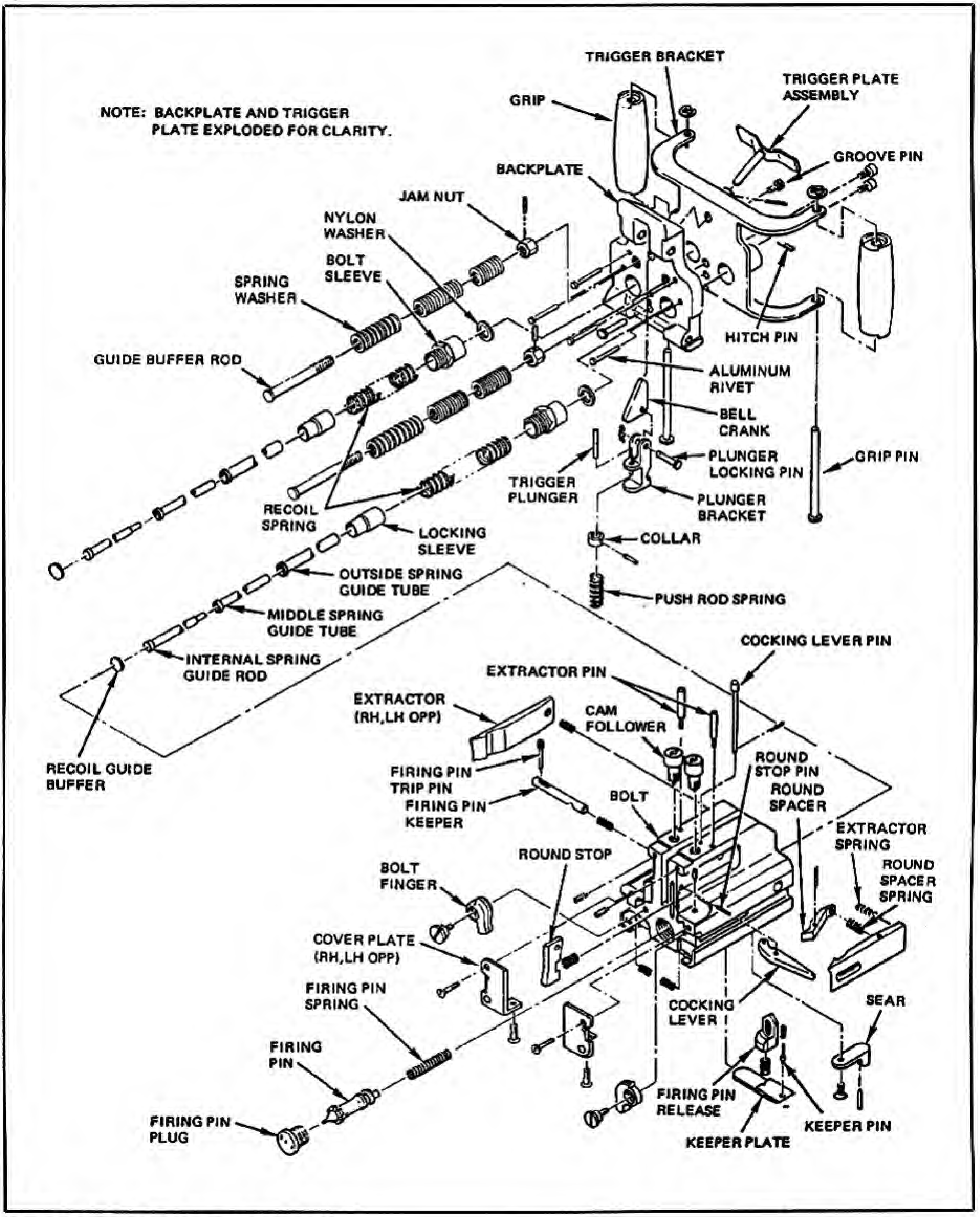
RECOIL/EXTRACTING/EJECTING

FEEDER ASSEMBLY
FIRING PIN TRIP
VERTICAL CAM
HORIZONTAL CAM
EXTRACTOR
BOLT
FEEDER SHUTTLE
ROCKER ARM
HORIZONTAL CAM
EXTRACTOR
BOLT
CAM FOLLOWER
PUSH PAWL
● PIVOT POINT
SLIDE AND LINK GUIDE
BARREL
BARREL BLOCK
ROUND
BOLT SEAR
TRIGGER SEAR
VERTICAL CAM
HORIZONTAL CAM
BUFFER ASSEMBLY
SPENT ROUND
RECOIL SPRING

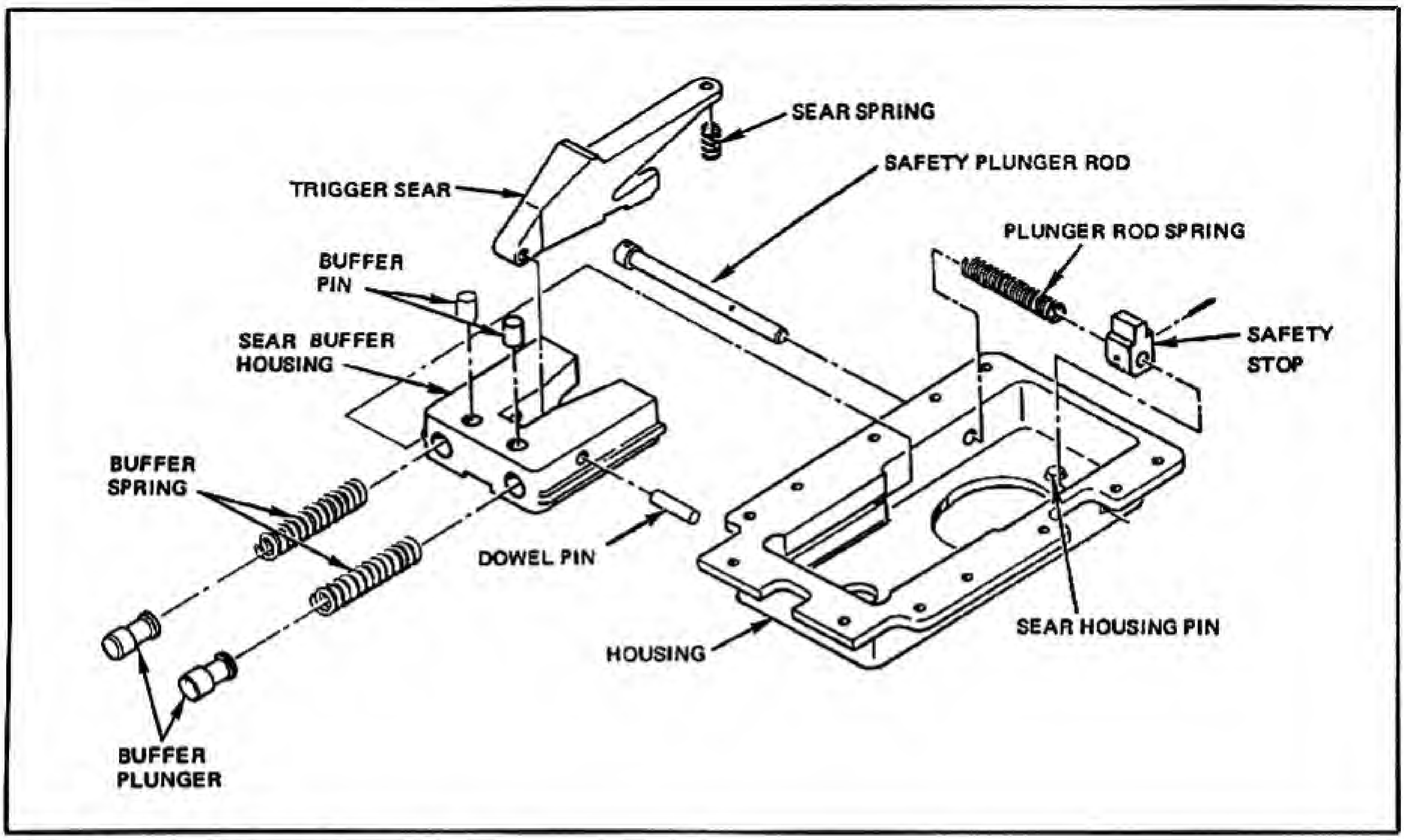
Mk 19 Mod 1 Sequence of Functioning


TOP COVER ASSEMBLY
UPPER BACKPLATE PIN ASSEMBLY
FRONT PLATE RECEIVER PIN
FEEDER GUIDE AND FEEDER SLIDE (REMAINS WITH TOP COVER WHEN REMOVED)
HORIZONTAL CAM
VERTICAL CAM
BUTTON HEAD CAP SCREW
FEEDER ASSEMBLY
RECEIVER ASSEMBLY
CAP SCREW
LOWER BACKPLATE PIN ASSEMBLY
SEAR HOUSING ASSEMBLY
SPACER
SOCKET HEAD CAP SCREW (6)
LOCKING PLATE
FLATHEAD CAP SCREW (10)
RESTRAINING PIN
CAP SCREW
BOLT AND BACKPLATE ASSEMBLY
NOTE: CHARGER BRACKET NOT SHOWN FOR CLARITY.

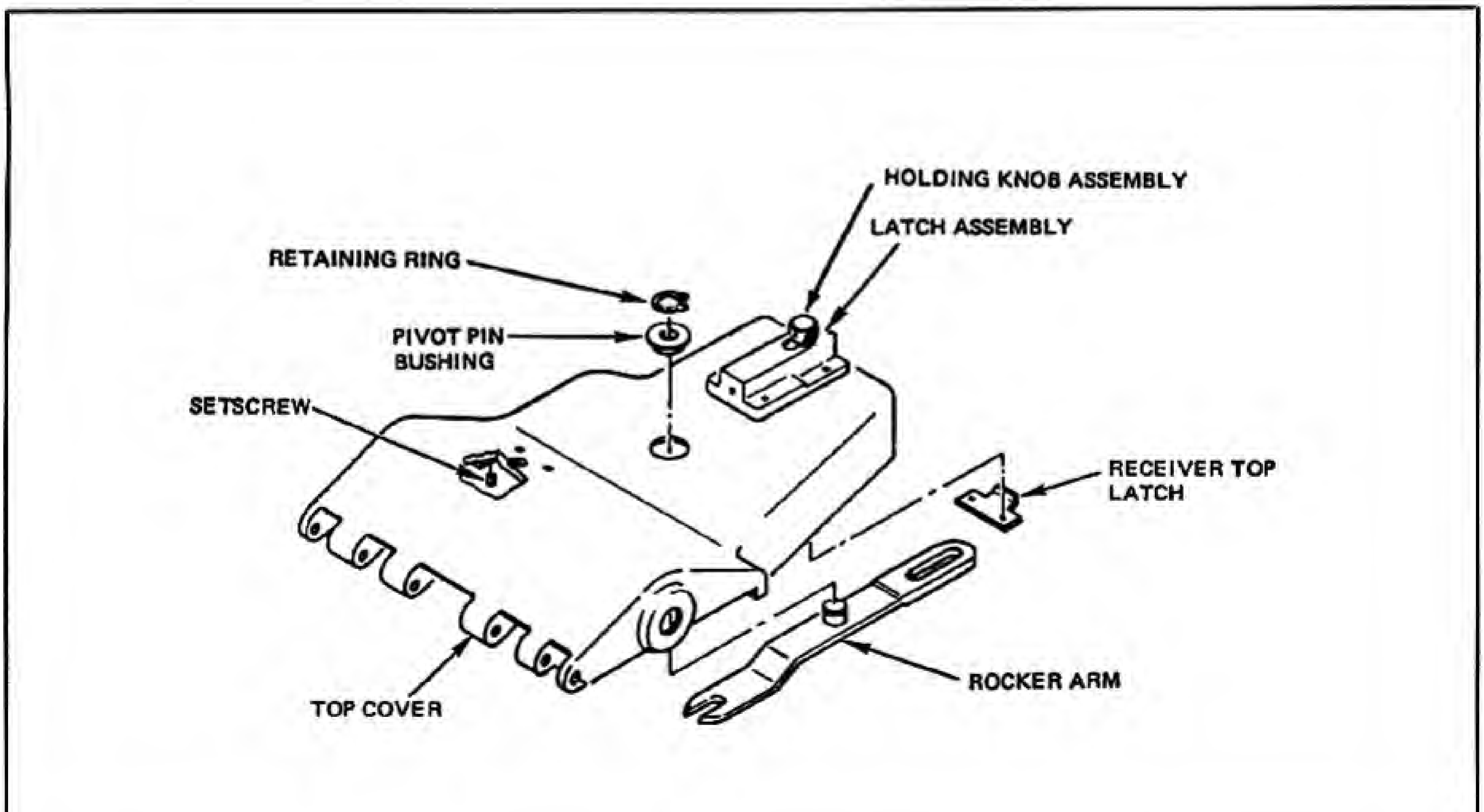
Mk 19 Mod 1 40mm Machine Gun Major Assemblies


NOTE: BACKPLATE AND TRIGGER PLATE EXPLODED FOR CLARITY.
TRIGGER BRACKET
TRIGGER PLATE ASSEMBLY
GRIP
GROOVE PIN
BACKPLATE
JAM NUT
NYLON WASHER
BOLT SLEEVE
SPRING WASHER
GUIDE BUFFER ROD
HITCH PIN
ALUMINUM RIVET
BELL CRANK
PLUNGER LOCKING PIN
GRIP PIN
TRIGGER PLUNGER
PLUNGER BRACKET
RECOIL SPRING
LOCKING SLEEVE
COLLAR
OUTSIDE SPRING GUIDE TUBE
PUSH ROD SPRING
MIDDLE SPRING GUIDE TUBE
COCKING LEVER PIN
INTERNAL SPRING GUIDE ROD
EXTRACTOR PIN
EXTRACTOR (RH,LH OPP)
CAM FOLLOWER
RECOIL GUIDE BUFFER
ROUND STOP PIN
FIRING PIN TRIP PIN
ROUND SPACER
FIRING PIN KEEPER
BOLT
EXTRACTOR SPRING
ROUND STOP
BOLT FINGER
ROUND SPACER SPRING
COVER PLATE (RH,LH OPP)
FIRING PIN SPRING
COCKING LEVER
SEAR
FIRING PIN
FIRING PIN RELEASE
FIRING PIN PLUG
KEEPER PIN
KEEPER PLATE

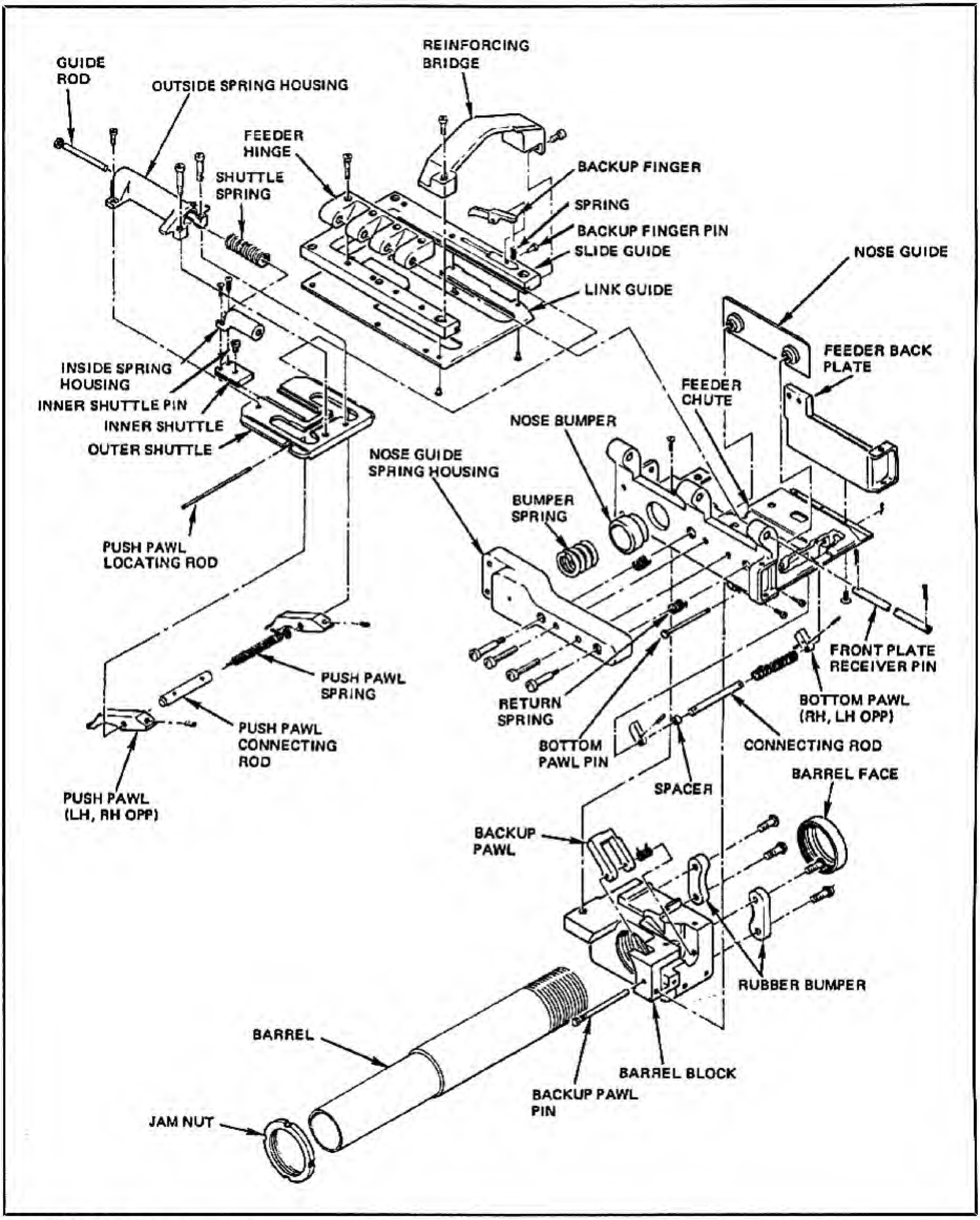
Mk 19 Mod 1 Bolt and Backplate Assembly


SEAR SPRING
SAFETY PLUNGER ROD
TRIGGER SEAR
PLUNGER ROD SPRING
BUFFER PIN
SEAR BUFFER HOUSING
SAFETY STOP
BUFFER SPRING
DOWEL PIN
SEAR HOUSING PIN
HOUSING
BUFFER PLUNGER

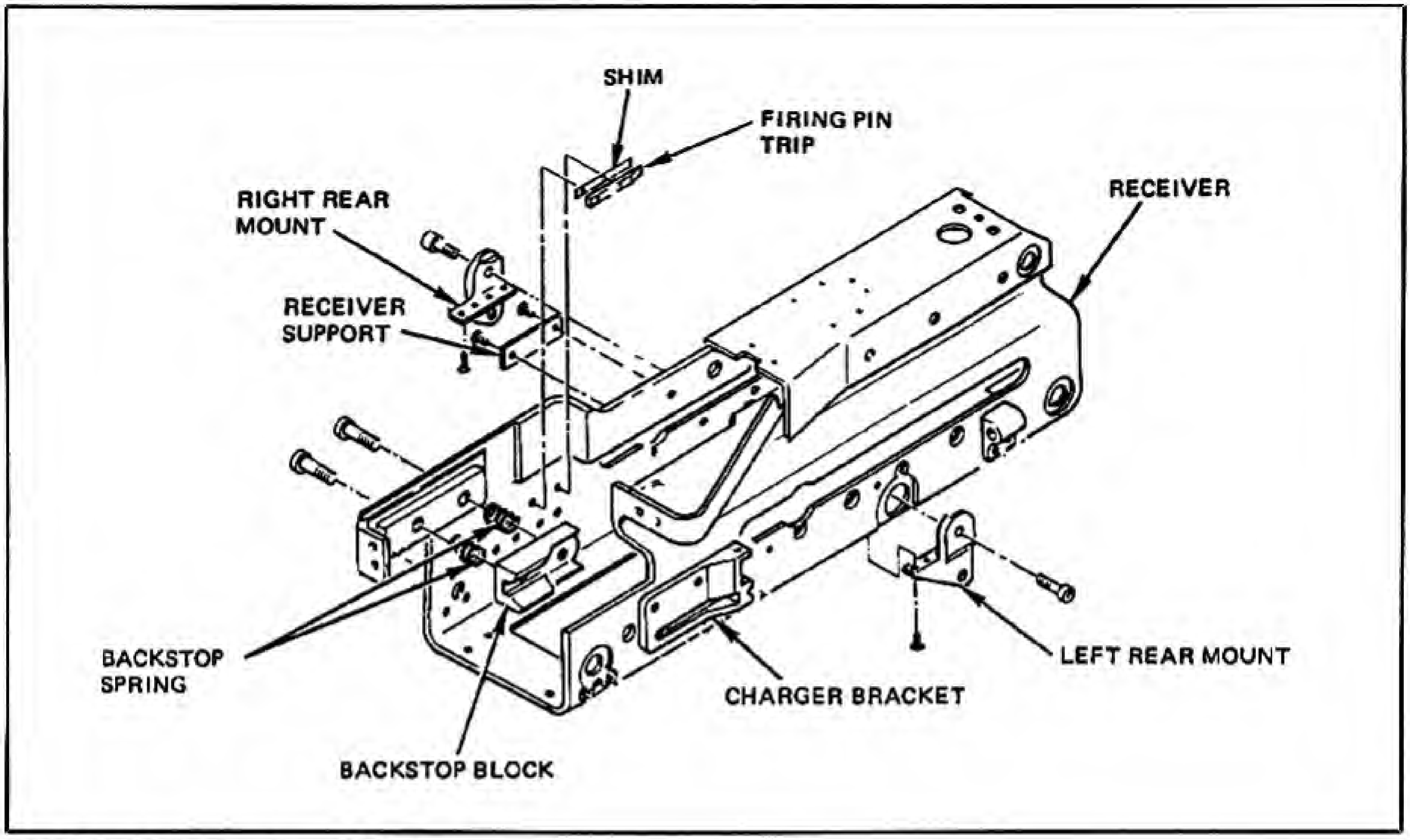
Mk 19 Mod 1 Sear Housing Assembly


HOLDING KNOB ASSEMBLY
LATCH ASSEMBLY
RETAINING RING
PIVOT PIN BUSHING
SETSCREW
RECEIVER TOP LATCH
ROCKER ARM
TOP COVER

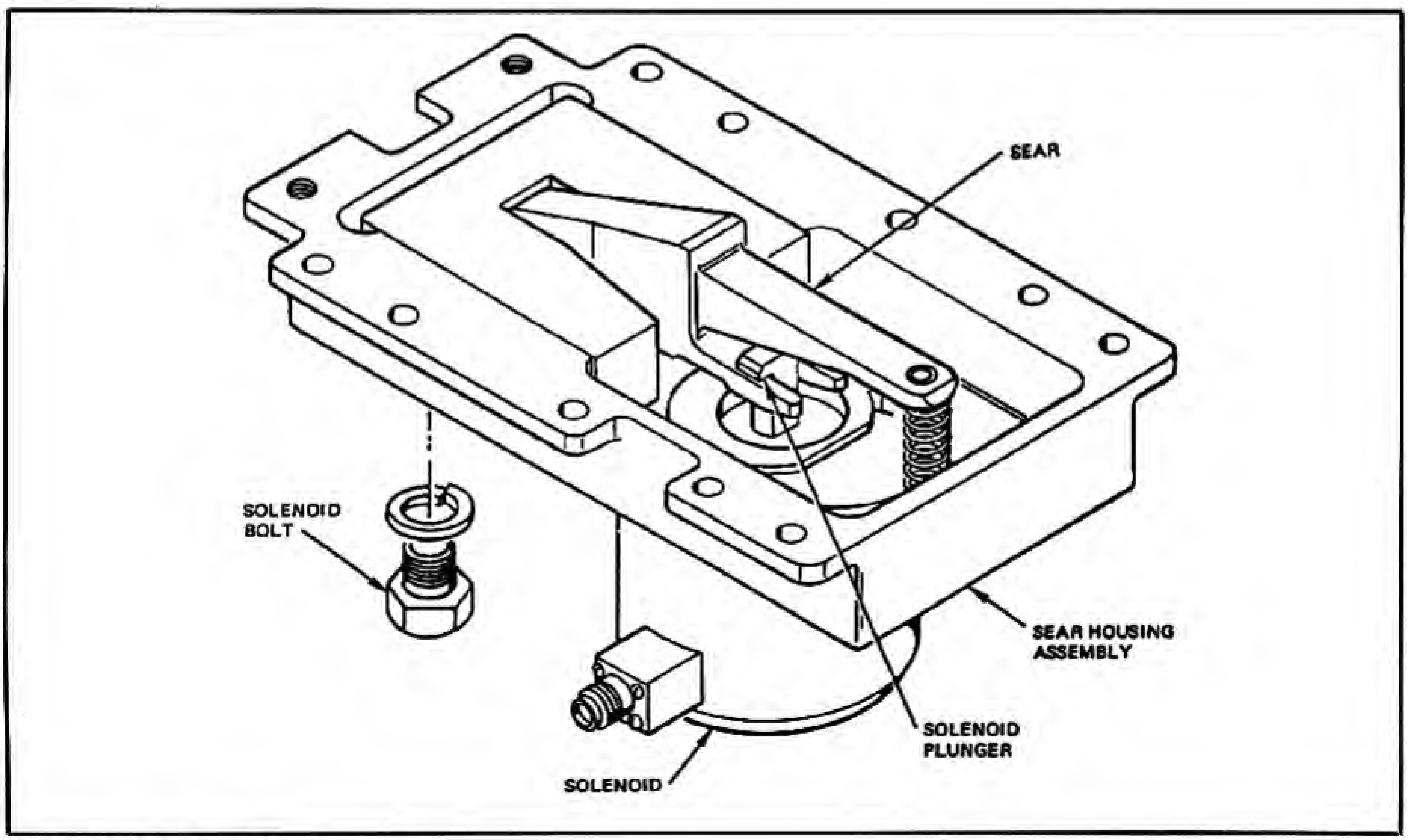
Mk 19 Mod 1 Top Cover Assembly


REINFORCING BRIDGE
GUIDE ROD
OUTSIDE SPRING HOUSING
FEEDER HINGE
SHUTTLE SPRING
BACKUP FINGER
SPRING
BACKUP FINGER PIN
SLIDE GUIDE
NOSE GUIDE
LINK GUIDE
FEEDER BACK PLATE
INSIDE SPRING HOUSING
INNER SHUTTLE PIN
INNER SHUTTLE
OUTER SHUTTLE
FEEDER CHUTE
NOSE BUMPER
NOSE GUIDE SPRING HOUSING
BUMPER SPRING
PUSH PAWL LOCATING ROD
PUSH PAWL SPRING
PUSH PAWL CONNECTING ROD
PUSH PAWL (LH, RH OPP)
FRONT PLATE RECEIVER PIN
BOTTOM PAWL (RH, LH OPP)
RETURN SPRING
BOTTOM PAWL PIN
CONNECTING ROD
SPACER
BARREL FACE
BACKUP PAWL
RUBBER BUMPER
BARREL
BARREL BLOCK
BACKUP PAWL PIN
JAM NUT

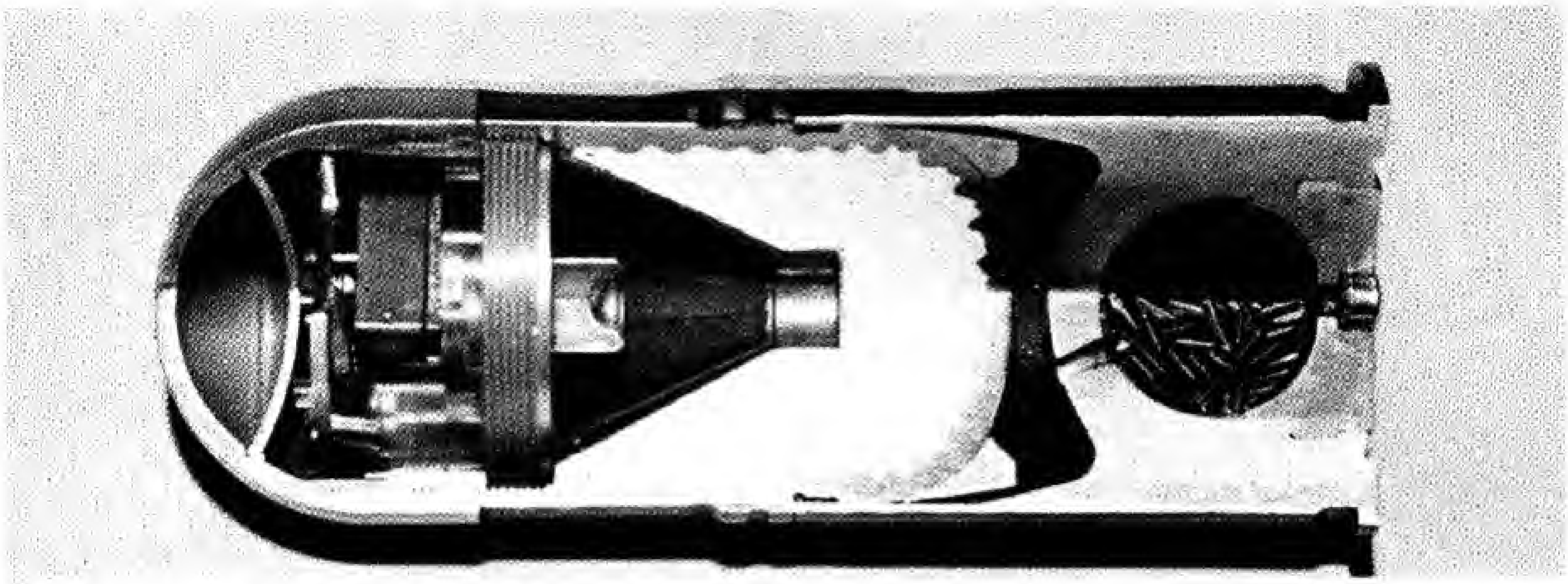
Mk 19 Mod 1 Feeder Assembly


SHIM
FIRING PIN TRIP
RECEIVER
RIGHT REAR MOUNT
RECEIVER SUPPORT
BACKSTOP SPRING
CHARGER BRACKET
LEFT REAR MOUNT
BACKSTOP BLOCK

Mk 19 Mod 1 Receiver Assembly

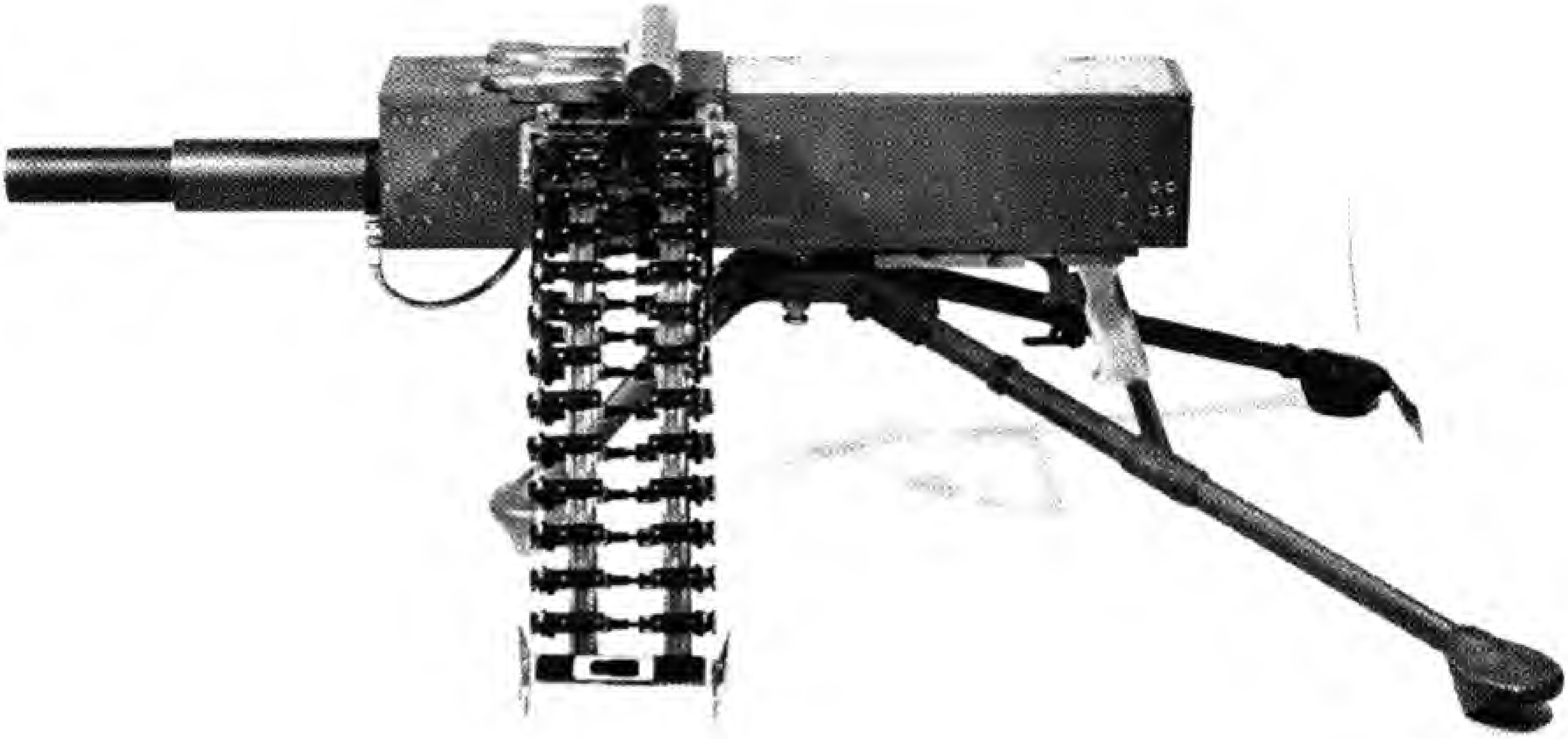

SEAR
SOLENOID BOLT
SEAR HOUSING ASSEMBLY
SOLENOID PLUNGER
SOLENOID

Mk 19 Mod 1 Solenoid Installation



Cartridge, 40mm HEDP, M430 Shaped Charge

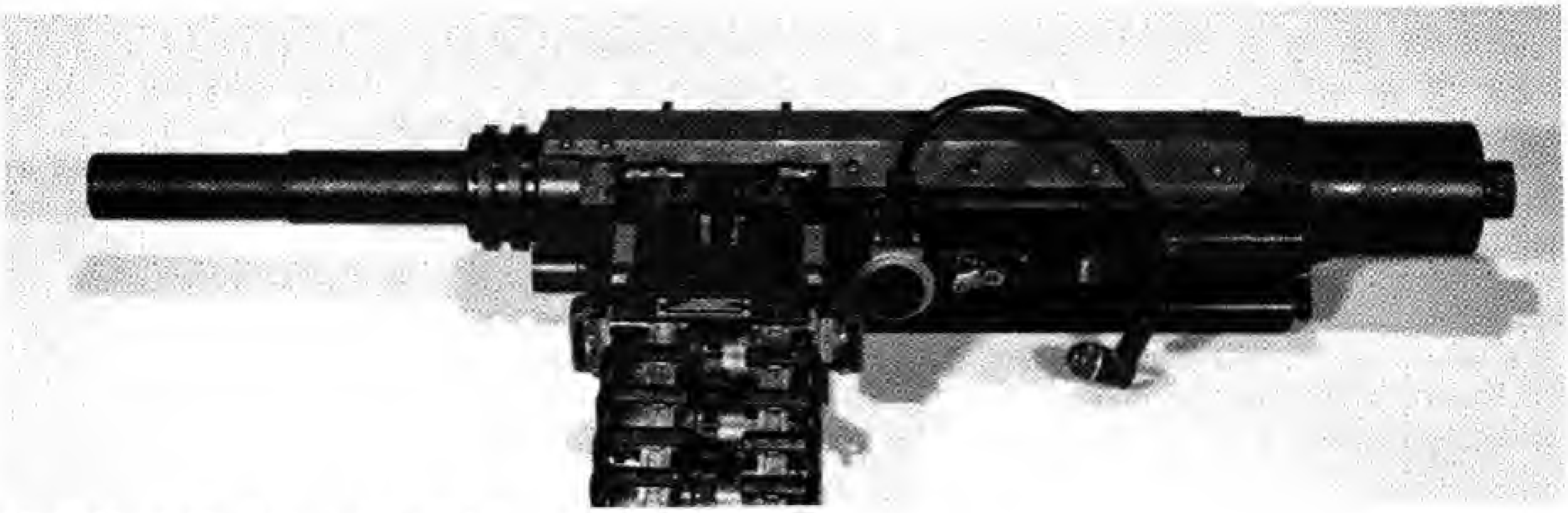
Mk 19 Mod 1 Mounted on Helicopter



First Prototype of Mk 19 with Gas Feeder

Mod 2 Characteristics

Weapon	Mk 19 Mod 2 (Grenade) 40mm Machine Gun
Developed by	Naval Ordnance Station Louisville
Status	Under Development
Method of Operation	Blowback (Advanced Primer Ignition)
Muzzle Velocity	800 fps
Rate of Fire	350 spm
Gun Weight	42 lbs.
Ammunition	M383, M384, M385



Mk 19 Mod 2 40mm Grenade Launcher

Discussion

The Mk 19 Mod 1 weapon successfully completed service certification tests and was recommended for unrestricted release to the fleet. Reliability of the Mk 19 Mod 1 gun during evaluation at Naval Weapons Laboratory, Dahlgren (NWL Dahlgren) was 600 rounds between stoppages, which is considered very good for a weapon of this type. Safety and reliability difficulties experienced with this weapon in the Mod 0 version were completely eliminated by design change in the Mod 1 gun.

Mk 19 Mod 2

There are always those who, although they have never originated anything themselves, can improve upon any device that is already in being and adequate for the purpose for which it was designed. This form of intelligentsia has always been in plentiful supply at NOSL, and the Vietnam conflict had hardly come to an end when a crash program was initiated with much vigor and unlimited funding to update the Mk 19 Mod 1. The reasoning being that anything that went from the drawing board to combat use in only seven months and twenty-two days, though it served with great distinction and held the high praise of the troops, must be badly in need of improvement.

After a two year effort that exhausted every facet of genius that was lurking on the premises, the Mk 19 Mod 2 venture resulted in a stream-line, eye-pleasing design, with weight equal to no more than the Mod 1. However, after innumerable proving ground trials, and the consertcd effort by all hands, the end result of the venture was that the Mk 19 Mod 2 had only one drawback - it would not shoot.

PROGRAM BACKGROUND - Mk 19 40mm Machine Guns

- Mk 19 Mod 0
  - — Developed Produced by NOS/L in 1966
  - — 810 Guns Produced
- Mk 19 Mod 1
  - — Result of Mod 0 Product Improvement Program in 1971
  - — 583 Mod 0's Converted to Mod 1's
  - — 761 New Mod 1's Produced
- Mk 19 Mod 3
  - — Result of Mod 1 Product Improvement Program in 1980
  - — 3 Engineering Development Models Produced
    - Reliability Tested July 1980 - 65% Improvement in MRBF over Mod 1
  - — Ordered on Priority Basis by 3 Services
    - FAD 1 Priority - USAF
    - FAD 2 Priority — USMC
    - DO-A5 Priority — USN

Mk 19 Mod 3

The Mk 19 Mod 3 machine gun exclusive of accessories is 34.6 inches long, 8.2 inches wide, and weighs 75 pounds. The gun is comprised of five major subassemblies: the bolt and backplate assembly, sear assembly, top cover assembly, feed slide assembly and tray, and receiver assembly. The receiver assembly is the major structure of the gun to which all other assemblies are attached.

When the receiver sear is depressed, the bolt is driven forward by spring pressure, carrying a round on the lower position of the bolt face. The round on the bolt face enters the barrel while the extractors on the upper portion of the bolt lock cover the rim of the cartridge in the feeder. With the bolt continuing its forward travel, the round is fired which immediately arrests the forward movement of the bolt and starts it in recoil. The bolt is driven to the rear by the blowback action while carrying with it the new round and the expended case. As the bolt continues its rearward movement, the new round is indexed down the bolt face into the firing position by the vertical cam. This action simultaneously expels the expended case out of the weapon. During recoil, as the bolt moves rearward, the left rail operates the cocking lever, feeds another round into position in the feeder. The bolt compresses the recoil springs and is buffered by the bolt buffers as it returns to the rear. If the receiver sear is depressed, the spring and buffers again drive the bolt forward, repeating the above sequence until the receiver sear is released.

This latest version, officially known as the Mk 19 Mod 3, is now in preproduction stage. Of the many prolonged attempts at refinement, the most significant is that of changing the means of obtaining its operational energy from advanced primer ignition to that of straight blow-back. These attempts have met with underwhelming success.

GENERAL SPECIFICATIONS

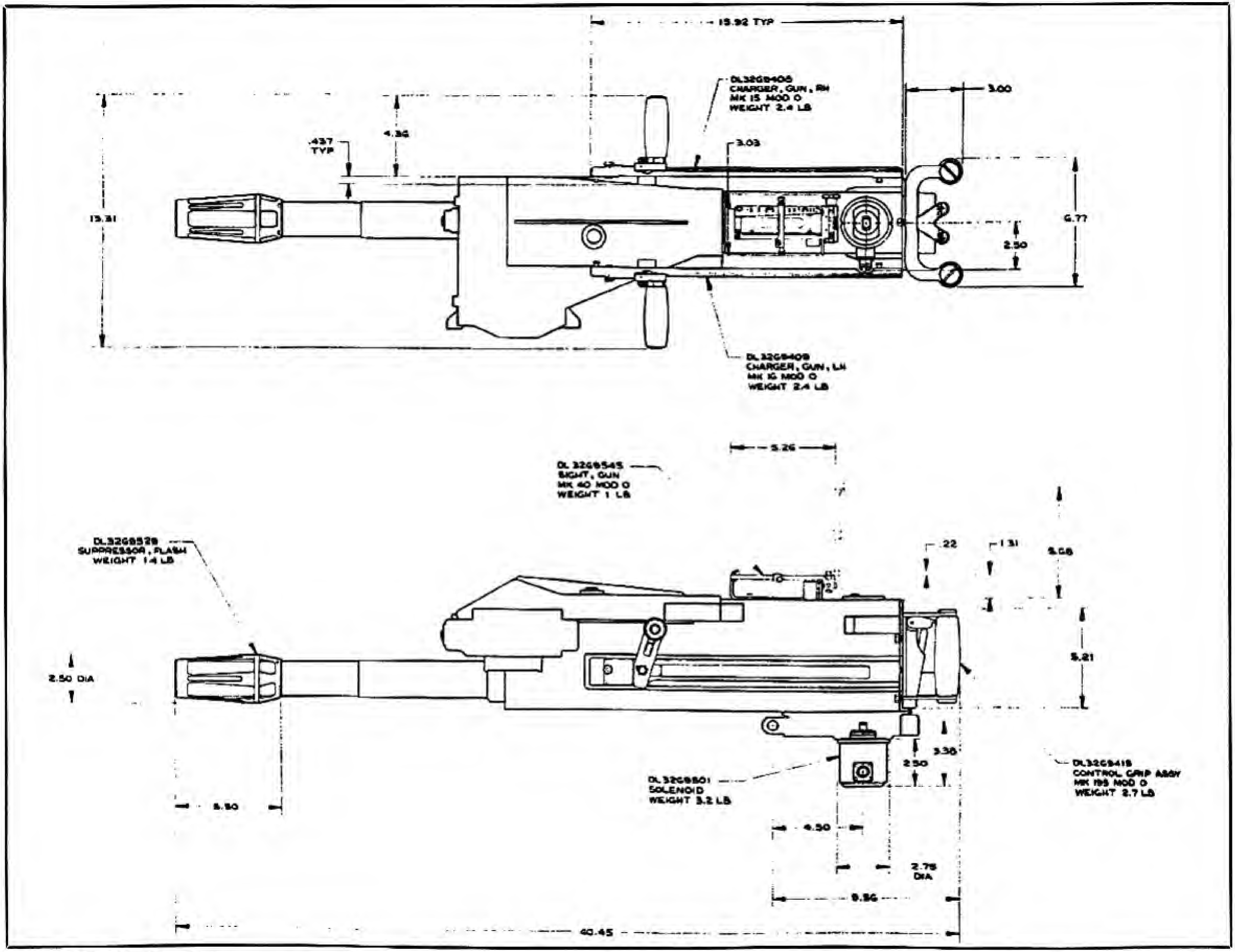
Mk 19 Mod 3

Weight of Gun	75.00 lbs.
Length of Gun	40.45 ins.
Width of Gun	13.31 ins.
Height of Gun	8.10 ins.
Muzzle Velocity	790 ft/sec (1200 ft/sec with I.V. Cartridge)
Maximum Effective Range	1600 m
Rate of Fire	325-375 rds/min
Reliability (Demonstrated Mean Rounds Between Failure)	3513 rds
Maintainability (Demonstrated Mean Time to Repair)	3.5 min.
Gun Life (Minimum)	50,000 rds
Mounts	Turrent, Tripod or Pedestal
Firing Mechanism	Electrical or Manual
Ammunition	40mm Grenades M383 (High Explosive) M384 (High Explosive) M385 (Practice) M430 (Dual Purpose HEDP)

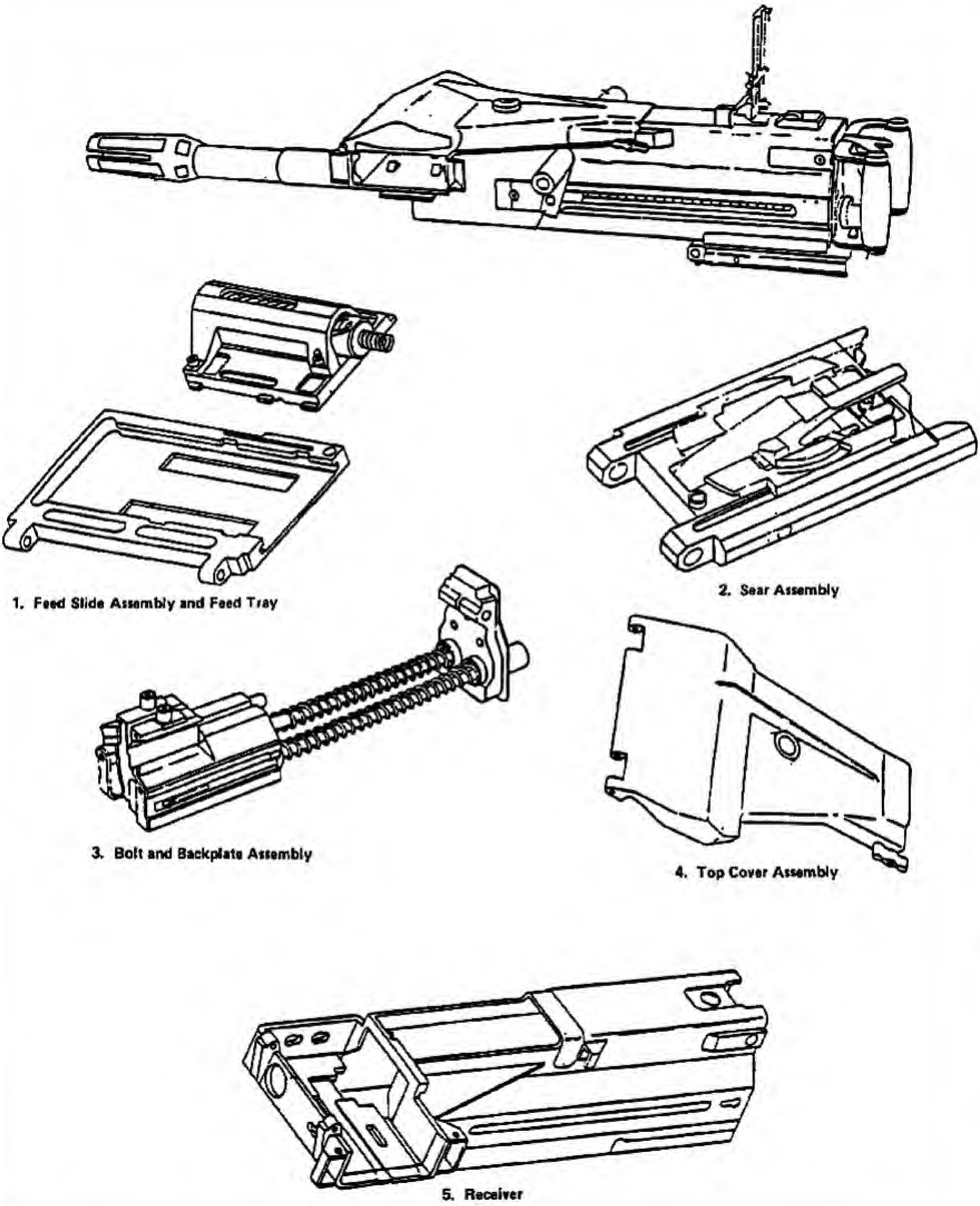
PRESENT PROGRAM STATUS

Mk 19 Mod 3

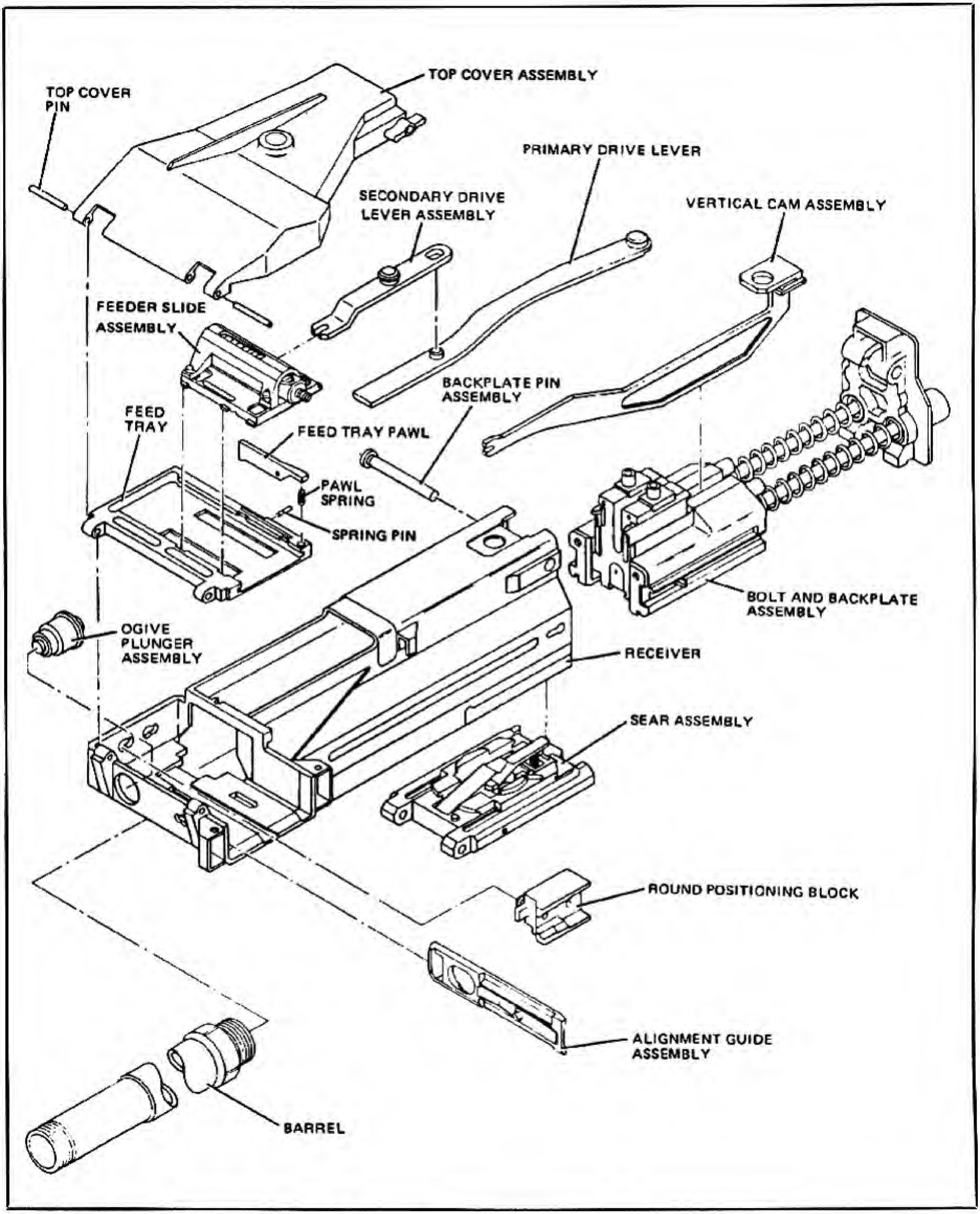
- Preproduction Phase - May 1981-Feb. 1983
  - — 8 Prepod Mod 3's will be delivered by NOS/L Sept. 1982
  - — ASU for Mk 19 Mod 3 Granted Dec. 1981
  - — ILSP Approved Jan. 1982
  - — Level III Drawings Signed Feb. 1983
- NOS/L Production Phase - Feb. 1982-Jul. 1984
  - — Production Lead Time - Feb. 1982-Oct. 1983
  - — Delivery: 285 Guns - Oct. 1983-Jul. 1984
    - 177 Guns - USAF
    - 108 Guns - USMC
- Industry Production Phase - May 1983
  - — Contract Award - May 1983
  - — Production Lead Time - May 1983-May 1984
  - — Delivery:
    - 1249 Guns (Firm) - May 1984- Apr. 1985
    - 1254 Guns - USMC
    - 161 Guns - USAF
    - 14 Guns - USN


15.92 TYP
DL32G8406
CHARGER, GUN, RH
MK 15 MOD 0
WEIGHT 2.4 LB
3.00
4.36
.437 TYP
3.03
13.31
6.77
2.50
DL32G8408
CHARGER, GUN, LH
MK 16 MOD 0
WEIGHT 2.4 LB
5.26
DL 32G8545
SIGHT, GUN
MK 40 MOD 0
WEIGHT 1 LB
DL32G8528
SUPPRESSOR, FLASH
WEIGHT 1.4 LB
.22
1.31
5.68
5.21
2.50 DIA
3.38
2.50
DL32G8418
CONTROL GRIP ASSY
MK 195 MOD 0
WEIGHT 2.7 LB
DL 32G8801
SOLENOID
WEIGHT 3.2 LB
5.50
4.50
2.75 DIA
9.86
40.45

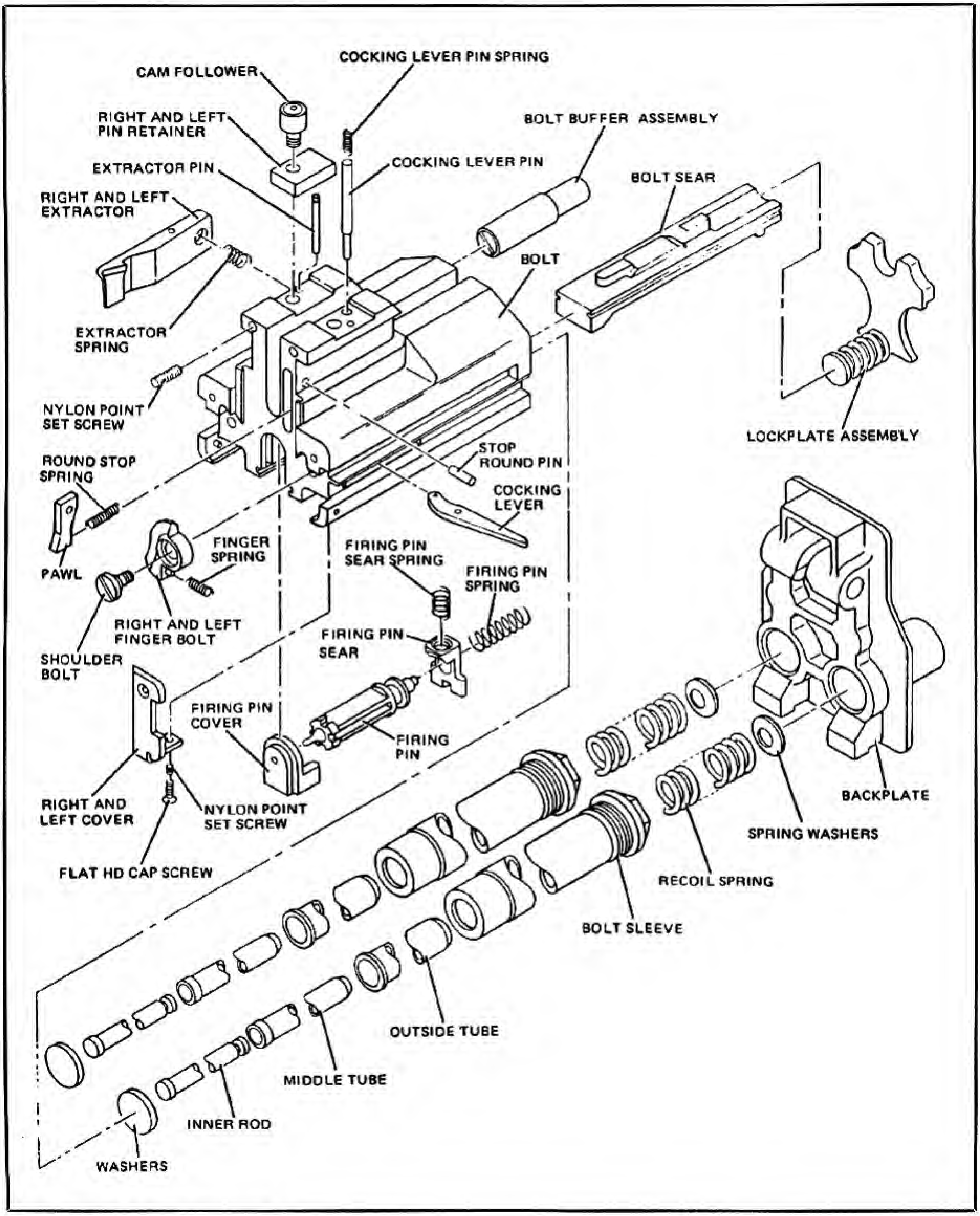
Mk 19 Mod 3 Machine Gun


1. Feed Slide Assembly and Feed Tray
2. Sear Assembly
3. Bolt and Backplate Assembly
4. Top Cover Assembly
5. Receiver

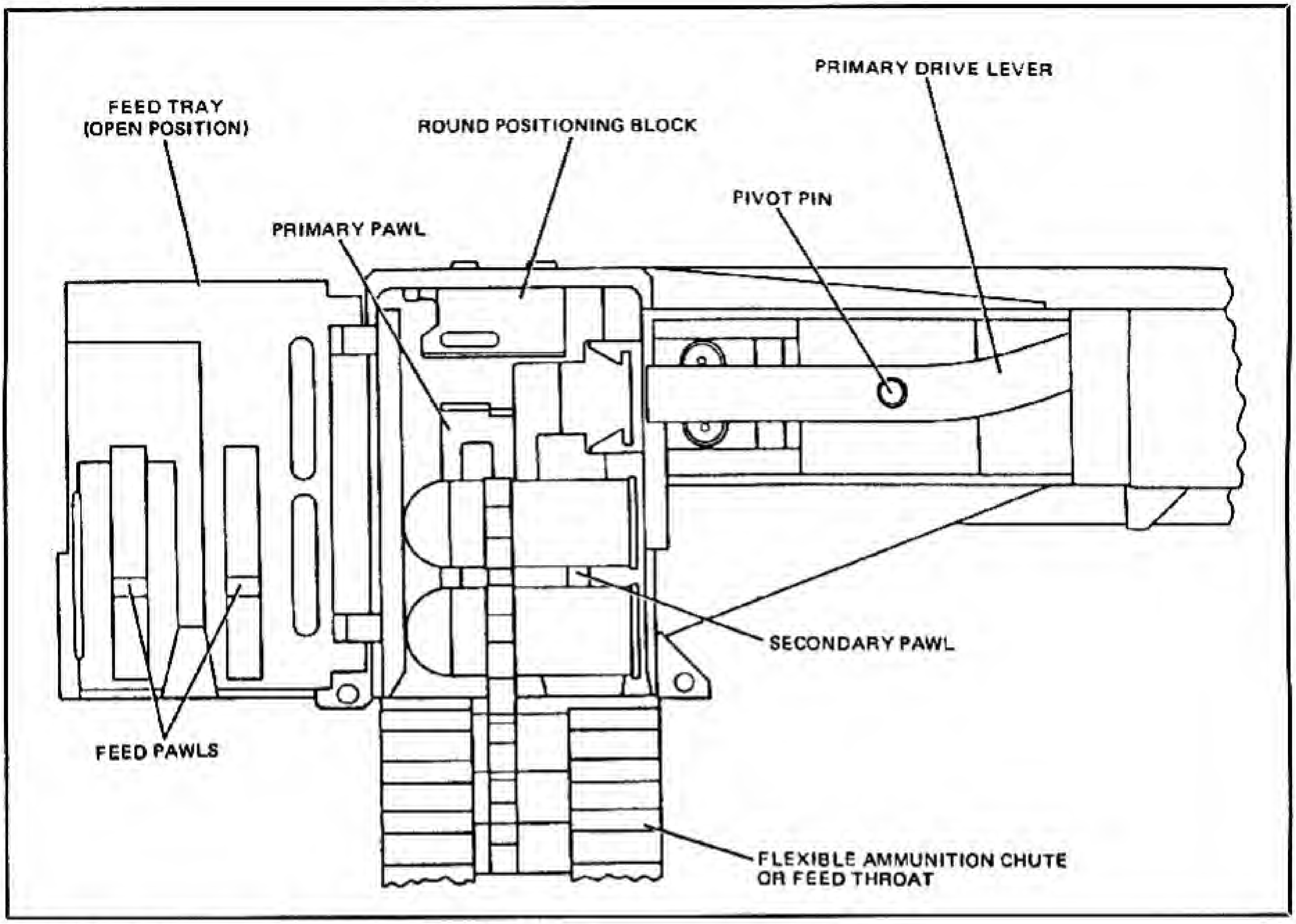
Mk 19 Mod 3 Assembled, Broken Down in Five Major Assemblies


TOP COVER PIN
TOP COVER ASSEMBLY
PRIMARY DRIVE LEVER
SECONDARY DRIVE LEVER ASSEMBLY
VERTICAL CAM ASSEMBLY
FEEDER SLIDE ASSEMBLY
BACKPLATE PIN ASSEMBLY
FEED TRAY
FEED TRAY PAWL
PAWL SPRING
SPRING PIN
BOLT AND BACKPLATE ASSEMBLY
OGIVE PLUNGER ASSEMBLY
RECEIVER
SEAR ASSEMBLY
ROUND POSITIONING BLOCK
ALIGNMENT GUIDE ASSEMBLY
BARREL

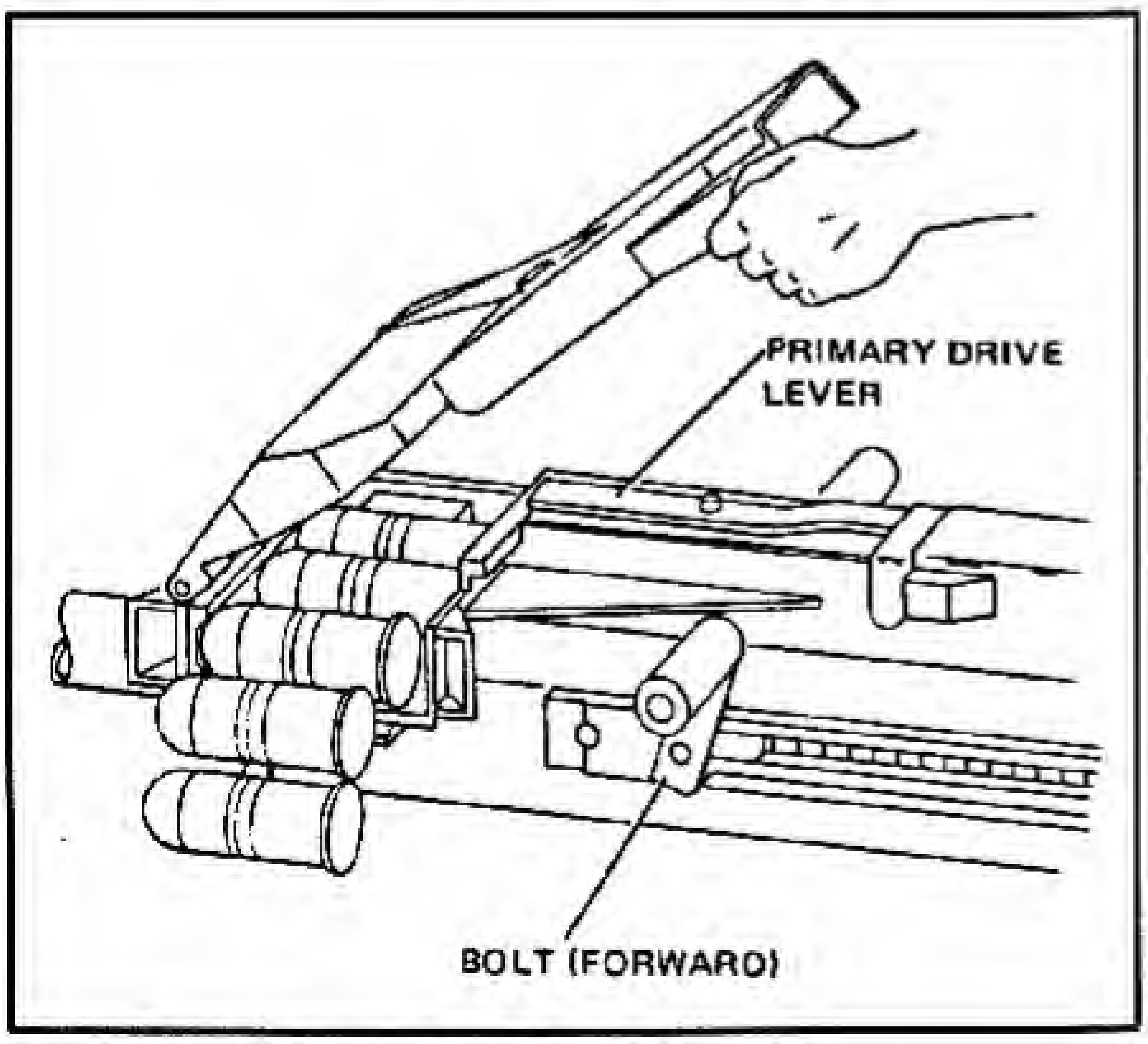
Mk 19 Mod 3 40mm Machine Gun Major Assemblies


CAM FOLLOWER
COCKING LEVER PIN SPRING
RIGHT AND LEFT PIN RETAINER
BOLT BUFFER ASSEMBLY
EXTRACTOR PIN
COCKING LEVER PIN
BOLT SEAR
RIGHT AND LEFT EXTRACTOR
BOLT
EXTRACTOR SPRING
NYLON POINT SET SCREW
LOCKPLATE ASSEMBLY
ROUND STOP SPRING
STOP ROUND PIN
COCKING LEVER
FINGER SPRING
PAWL
FIRING PIN SEAR SPRING
FIRING PIN SPRING
RIGHT AND LEFT FINGER BOLT
FIRING PIN SEAR
SHOULDER BOLT
FIRING PIN COVER
FIRING PIN
RIGHT AND LEFT COVER
NYLON POINT SET SCREW
BACKPLATE
SPRING WASHERS
FLAT HD CAP SCREW
RECOIL SPRING
BOLT SLEEVE
OUTSIDE TUBE
MIDDLE TUBE
INNER ROD
WASHERS

Mk 19 Mod 3 Bolt and Backplate Assembly


PRIMARY DRIVE LEVER
FEED TRAY
(OPEN POSITION)
ROUND POSITIONING BLOCK
PIVOT PIN
PRIMARY PAWL
SECONDARY PAWL
FEED PAWLS
FLEXIBLE AMMUNITION CHUTE
OR FEED THROAT

Mk 19 Mod 3 Positioning Rounds in Feeder Mechanism

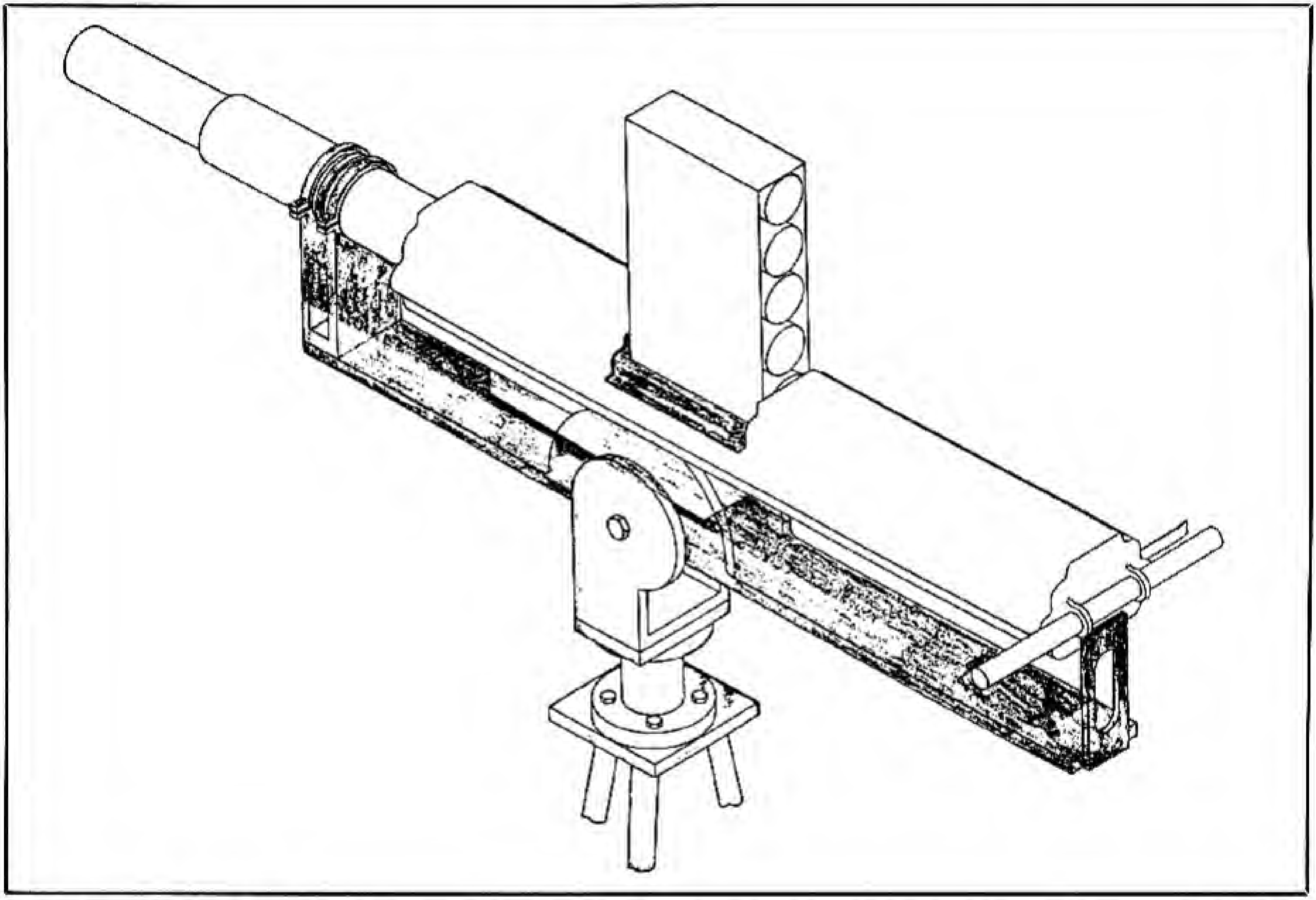

PRIMARY DRIVE
LEVER
BOLT (FORWARD)

Mk 19 Mod 3 Closing Top Cover Assembly

Chapter 66

70mm AUTOMATIC GRENADE LAUNCHER

NAVAL ORDNANCE STATION LOUISVILLE (Concept)



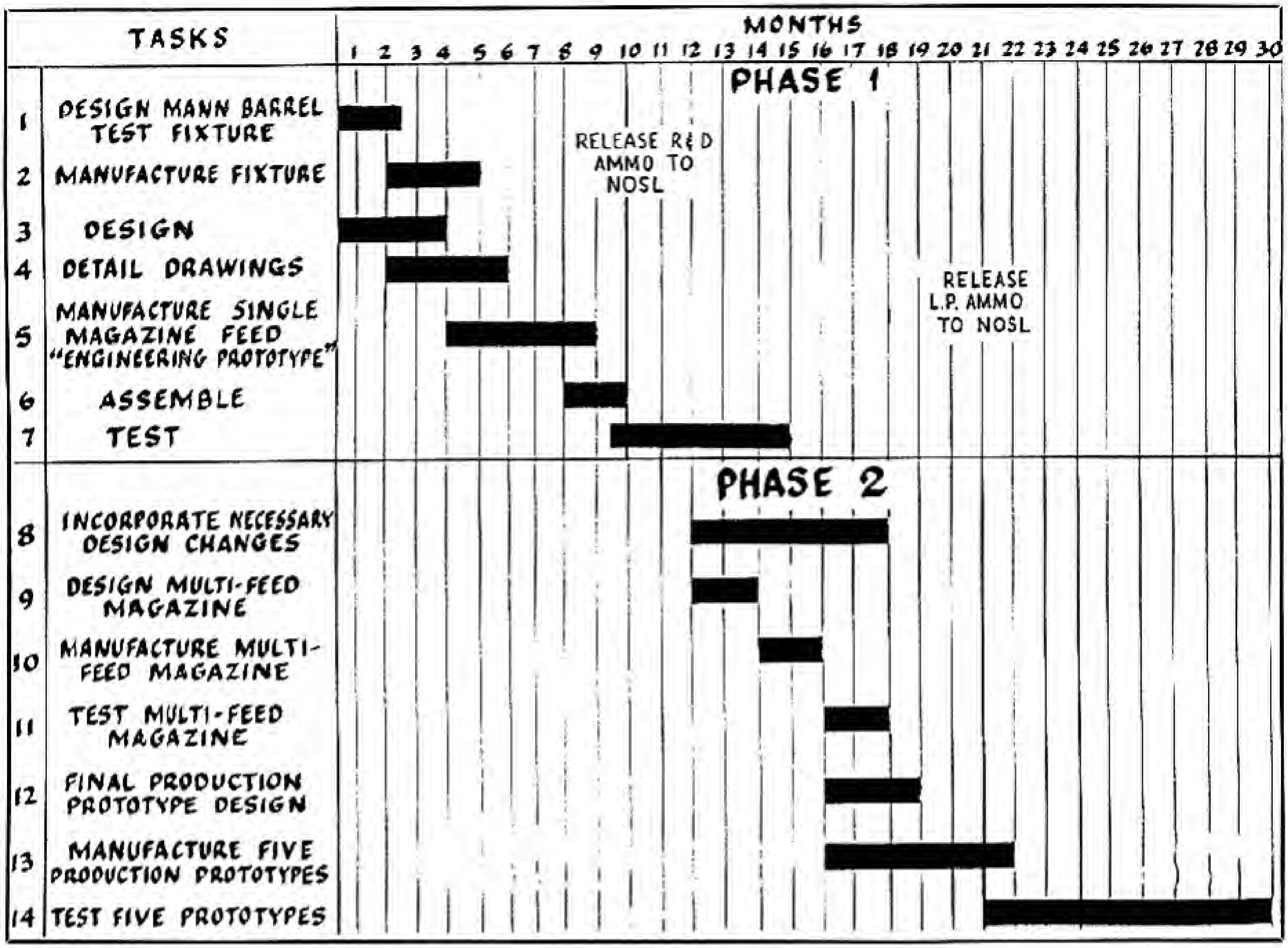
70mm Grenade Launcher

History

In the late 1960's NOS/Louisville proposed a semi-automatic or automatic 70mm Grenade Launcher. The gun's principle and operation was "extended" short recoil and advanced primer ignition.

The ammunition proposed was a cased high-low pressure round, a scaled up version of the conventional high velocity cartridge employed in the Mk 19 automatic grenade launcher.

This weapon would have the capability of fulfilling various roles of the Navy small boats on both offense and defense. Its primary use would be to provide the craft with a high concentration of firepower against both personnel and material targets. A demoralizing effect on the insurgents would be obtained from the unexpected use of rapid, high



Weapon Schedule

TASKS	PHASE 1	TASKS	PHASE 2
1	23,000	8	82,000
2	31,000	9	26,000
3	58,000	10	20,000
4	61,000	11	28,000
5 & 6	121,000	12	32,000
7	34,000	13	380,000
		14	78,000
	$328,000		$646,000

TOTAL - $974,000

Weapon Cost

explosive fragmenting ammunition. The weapon could also be used to provide suppressive covering fire for the embarking and debarking troops from landing craft. The launcher's relatively small configuration and light weight would make it easily adaptable for small craft and outpost defense. With proper warhead configuration bunker penetration could be obtained.

General Description

Since the development of the 40mm grenade with both single shot and fully automatic launchers, the use of this round has proven highly satisfactory. With this in mind it would seem desirous to pursue grenade development with increases in both range and size of the warhead. It was proposed that a 70mm Automatic Grenade Launcher be designed for use from small craft which are presently capable of firing the Mk 19 grenade launcher and the calibre .50 machine gun. The increased grenade range and warhead would be highly effective against ambush and area saturation before troop movement. The design of the 70mm grenade launcher would be similar to that of the Mk 19 Automatic Launcher developed at Naval Ordnance Station/Louisville. The weapon would be belt fed and operated by one man. Research and development would also be needed on a 70mm grenade round.

Characteristics

Bore Size	70mm
Muzzle Velocity	1100 ft/sec
Rate of Fire	350 rpm
Basic Systems of Operation	Advanced Primer Ignition and Extended Short Recoil
Firing Cycle	Starts from Open Bolt
Fire Capability	Single Shot or Full Automatic
Feed System	Magazine and/or Belt Fed
Type of Feed (location)	Clip
Method of Charging	Manually
Target Use	Personnel, Bunkers, etc.
Range	4000
Manufacturer	Naval Ordnance Station/Louisville
Ammunition	Cased High-Low Pressure Round
Gun Weight	110 lbs.

Cycle of Operation

To load, the feeder cover is opened and the flexible feed chute put in place. The linked rounds are fed from the ammunition can through the flexible feed chute and the gun feeder until the first round is seated in the back stop. The bottom pawls must be in the up position. The bolt is pushed forward until the extractors snap over the rim of the round against the back stop. The cover is then closed.

The bolt is pulled to the rear until it engages the trigger sear. The safety lever is pushed to the horizontal position placing the weapon on "SAFE."

When the safety lever is in the vertical position, the gun is on "FIRE." Either the hand trigger or the solenoid will release the sear and allow the bolt to go forward into battery.

With the cover group raised and the bolt seared to the rear, the first round in the belt is placed in position in the round stop pawls. Closing the cover group and triggering the bolt off sear permits pickup jaws to engage rim of the first round. Pulling the bolt to the rear delivers the first round, cocks the firing pin, indexes the round down the vertical cam in its battery position and leaves the bolt on sear ready to fire. The second round is indexed into pickup position by the horizontal cam, rocker arm, and feeder shuttle.

Releasing the sear permits the drive springs to push the bolt forward into battery firing the round 5/16″ out of battery position with the link pushed to the rear 3/4″ from the base of the round.

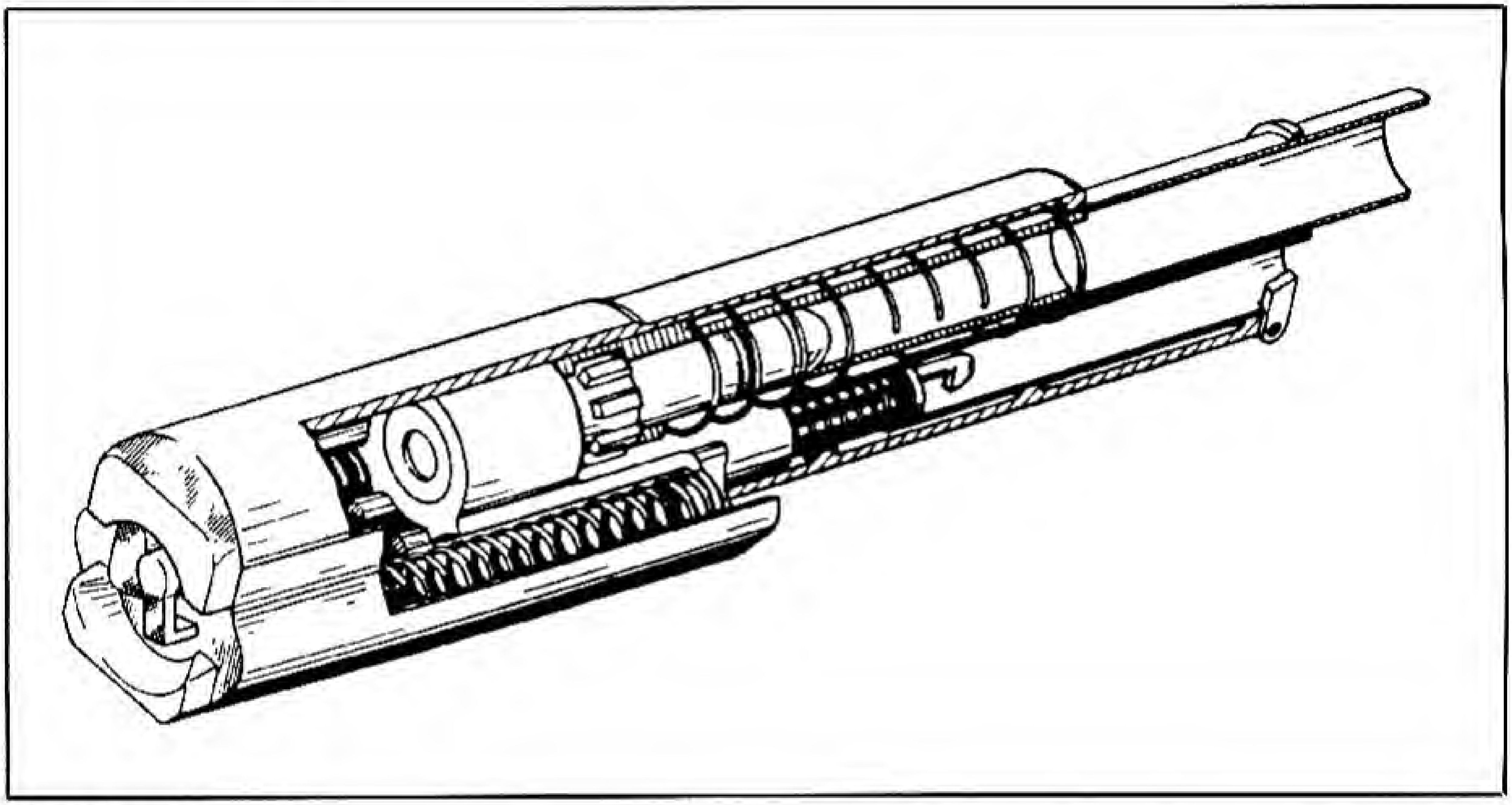
This proposal by NOS/Louisville was terminated as was the bolt 70mm concept due to no requirement.

Comparison of a 40mm Projectile and a 70mm Projectile.

Chapter 67

70mm AUTOMATIC GRENADE LAUNCHER

COLT (Prototype)



70mm Grenade Launcher

History

In 1970, Colt presented an unsolicited proposal for the development of a 70mm grenade launcher, which was essentially a larger version of the present 40mm grenade launchers. Colt proposed and did preliminary work on a caseless round for the weapon and presented four different weapons concepts, none of which were further developed.

General Characteristics

This concept embodies a light, semiautomatic cannon which fires with the gun at rest in battery position. This firing approach has been chosen because it promises to offer excellent accuracy potential when fired from a maneuvering, pitching or vibrating platform, as well as low bulk and weight.

This gun has been designed to utilize either of the two caseless cartridge concepts proposed. The addition of artillery type extractor-ejectors and a deepening of the receiver would enable this weapon to handle cased ammunition. The 36″ barrel should minimize muzzle blast and gun gasses around the operator's station.

As headspacing is controlled by engagement of the rifling band against the rifling lead, ramming velocity is limited to a low impact rate; i.e., about 6 ft/sec. This minimizes engraving of the band, facilitating extraction when unloading is desired.

Recoil energy is absorbed by two hydraulic buffers and two pneumatic recuperators grouped around the barrel, comprising the forward receiver. Recoil energy is absorbed at a constant rate during a 25 inch maximum recoil stroke, giving a 2,000 lb. trunnion reaction during the .052 sec. of recoil imparted by the 45 lb. recoiling mass.

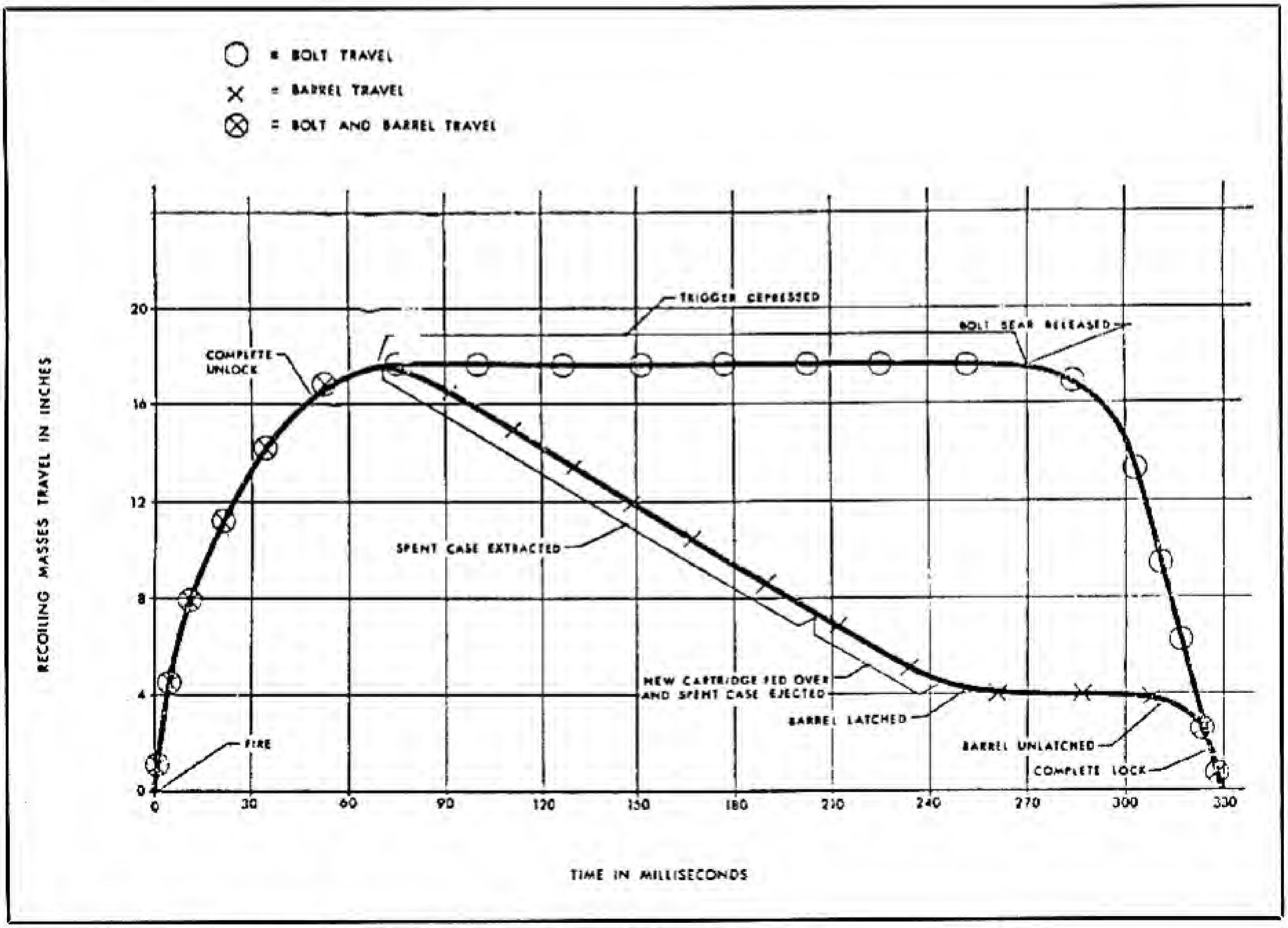
As a constant recoil distance is difficult to achieve with every shot fired and excess recoil would result in heavy force peaks, the weapon is designed to self-load and operate satisfactorily on short recoils up to 2.5 in. below the 25 inch maximum recoil travel.

Characteristics

Bore Size	70mm
Muzzle Velocity	850 fps
Rate of Fire	150 rpm
Basic System of Operation	Short/Recoil
Power Source Feed System	Recoil
Feed System	Magazine
Method of Chambering	Ram
Initial Extraction	Mechanical
Weapon by Source	Private
Gun Size:	
Length	48 in.
Width	8 in.
Height	10 in.
Weight	110 lbs.
Barrel Length	20 in.
Method of Charging	Manual Mechanical Charger

Operating Cycle

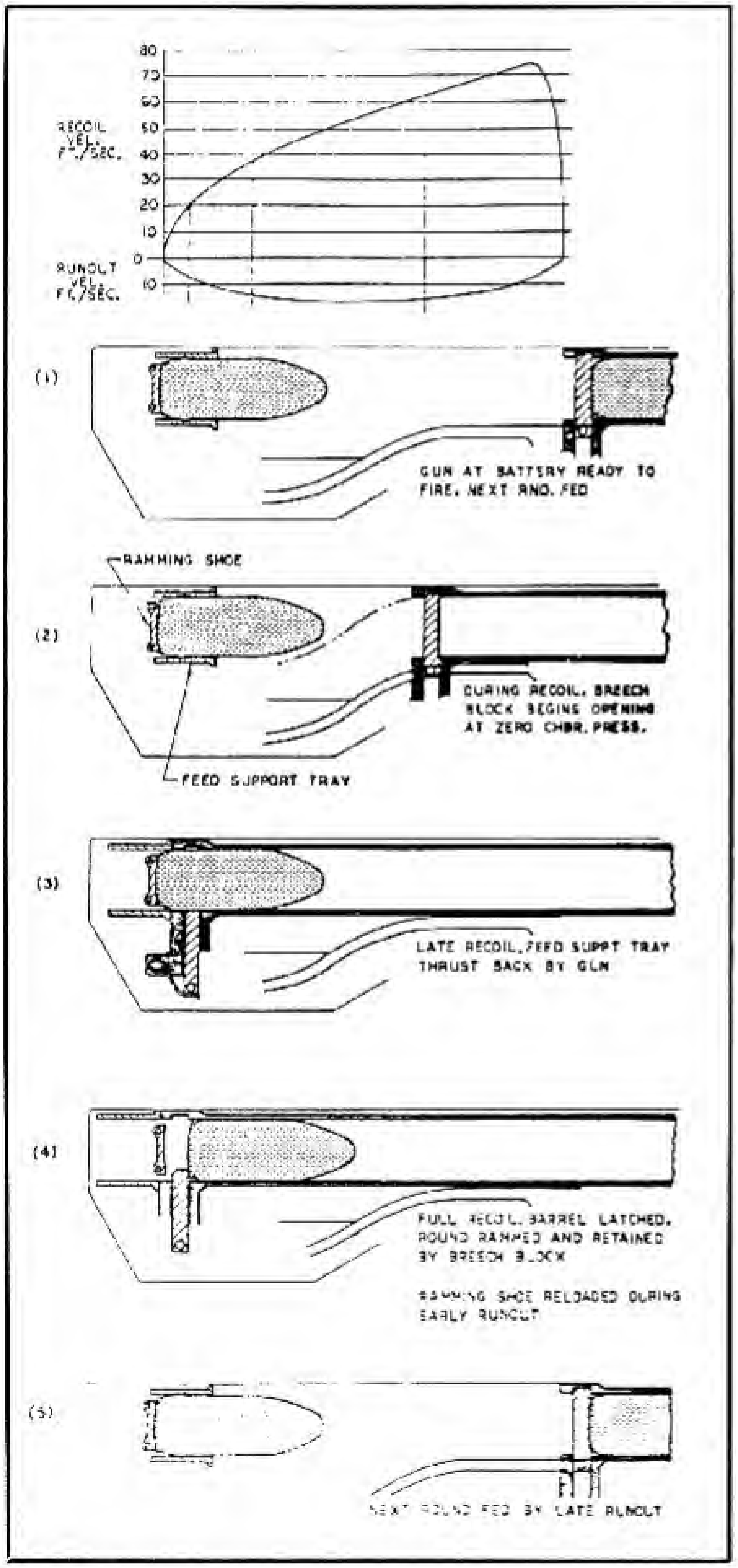
The cycle begins with the locked and loaded gun forward in battery position. A second round has been cross fed during runout into central in alignment with the barrel.



Estimated Time Displacement Curve for Colt's 70mm Grenade Launcher

Upon firing (by a rocker hammer pivoted on the breech ring) the locked gun recoils. When chamber pressure reaches atmospheric the breech block begins to be displaced by cam action. With no cartridge case to be ejected, the barrel comes back over the fed round during the latter portion of recoil.

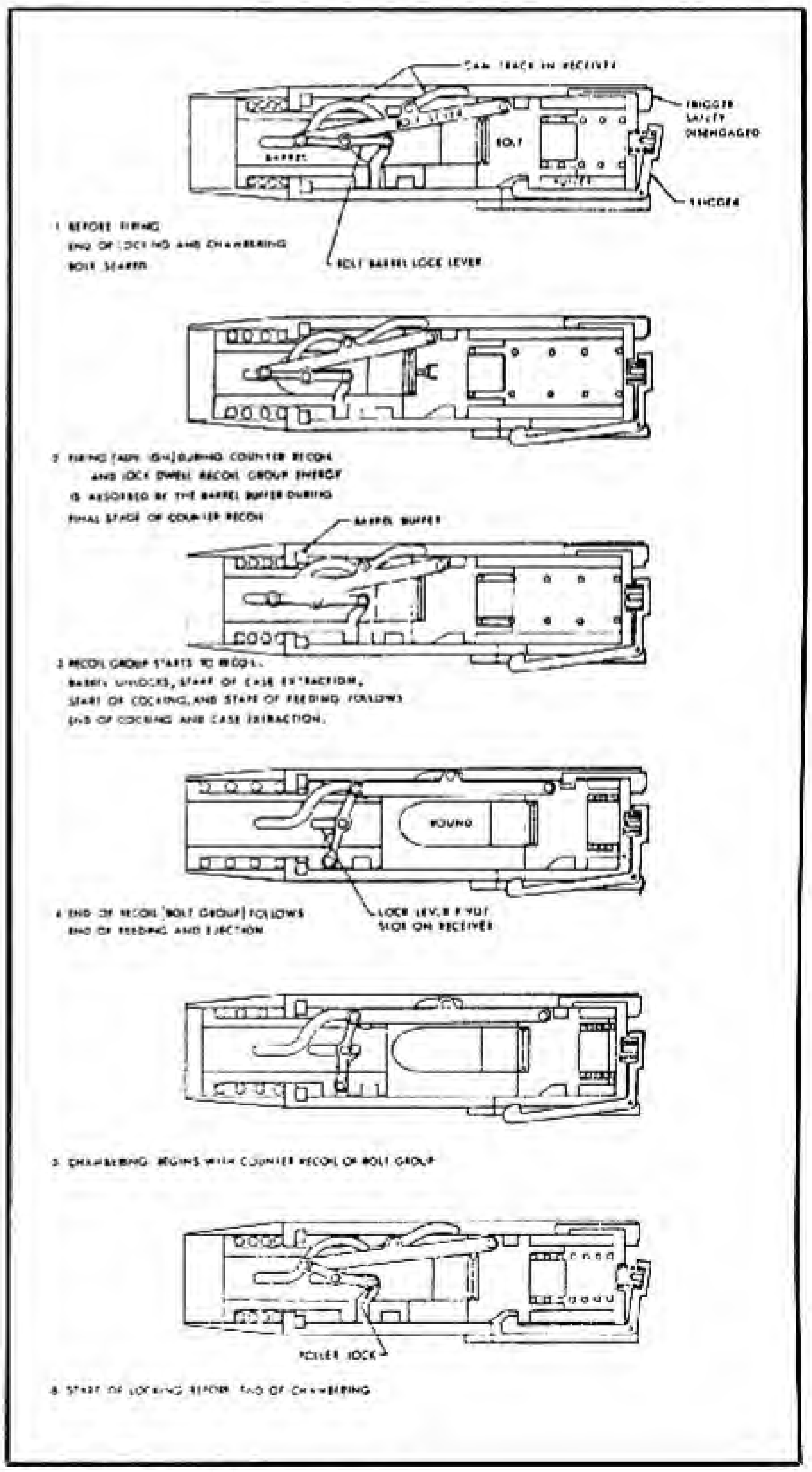
During the last part of recoil, the feed support tray is thrust rearward by the barrel; but the cartridge it supports is held in fed position by the ramming shoe. Meanwhile, the end of the breech block cam allows the spring loaded breech block to rise until it touches the partly-chambered cartridge.


80
70
60
50
40
30
20
10
0
10
RECOIL VEL. FT./SEC.
RUNOUT VEL. FT./SEC.
(1)
GUN AT BATTERY READY TO FIRE. NEXT RND. FED
RAMMING SHOE
(2)
DURING RECOIL, BREECH BLOCK BEGINS OPENING AT ZERO CHBR. PRESS.
FEED SUPPORT TRAY
(3)
LATE RECOIL, FEED SUPPT TRAY THRUST BACK BY GUN
(4)
FULL RECOIL, BARREL LATCHED, ROUND RAMMED AND RETAINED BY BREECH BLOCK
RAMMING SHOE RELOADED DURING EARLY RUNOUT
(5)
NEXT ROUND FED BY LATE RUNOUT

Cycle of Operation

The barrel is momentarily latched upon reaching the maximum recoil (which may be a short recoil). The resulting forward reaction on the latch releases the rammer and the fed round is fully chambered. The breech block then partially rises behind the chambered round to prevent its escape during barrel runout.

Release of the breech block triggers release of the barrel latch. The recuperator causes the barrel to run out relatively slowly. The cam positively closes the

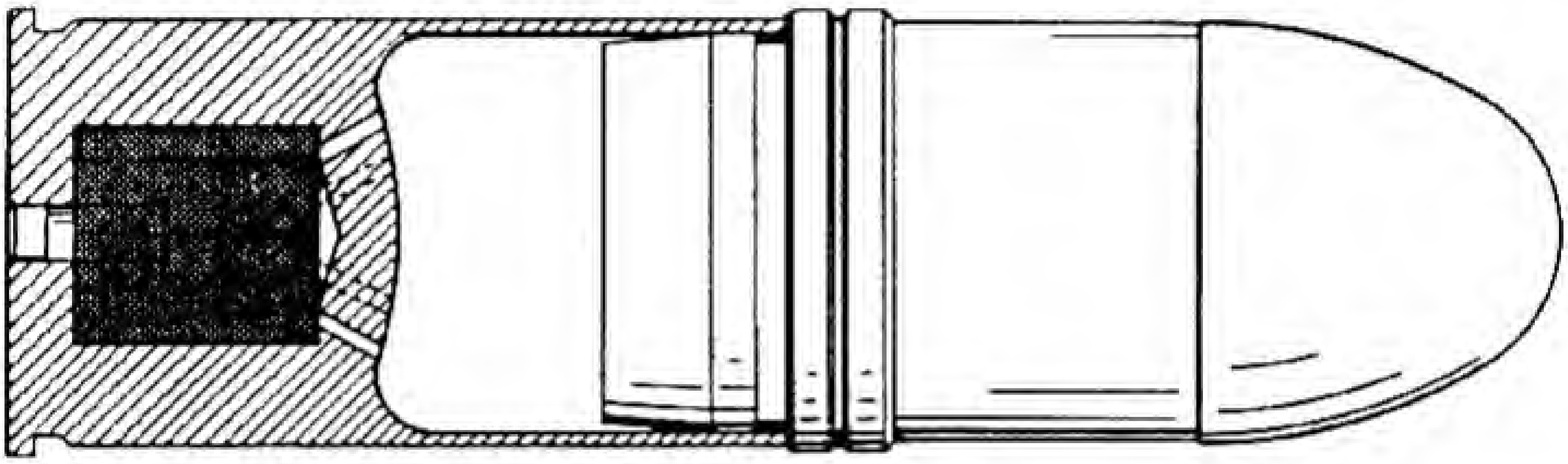

CAM TRACK IN RECEIVER
TRIGGER SAFETY DISENGAGED
BOLT
BARREL
BUFFER
TRIGGER
1 BEFORE FIRING
END OF LOCKING AND CHAMBERING
BOLT SEARED
BOLT BARREL LOCK LEVER
2 FIRING (AMM IGN) DURING COUNTER RECOIL
AND LOCK DWELL. RECOIL GROUP ENERGY
IS ABSORBED BY THE BARREL BUFFER DURING
FINAL STAGE OF COUNTER RECOIL
BARREL BUFFER
3 RECOIL GROUP STARTS TO RECOIL.
BARREL UNLOCKS, START OF CASE EXTRACTION,
START OF COCKING, AND START OF FEEDING FOLLOWS
END OF COCKING AND CASE EXTRACTION.
ROUND
4 END OF RECOIL (BOLT GROUP) FOLLOWS
END OF FEEDING AND EJECTION
LOCK LEVER PIVOT
SLOT ON RECEIVER
5 CHAMBERING BEGINS WITH COUNTER RECOIL OF BOLT GROUP
ROLLER LOCK
6 START OF LOCKING BEFORE END OF CHAMBERING

Modified Short Recoil Principle

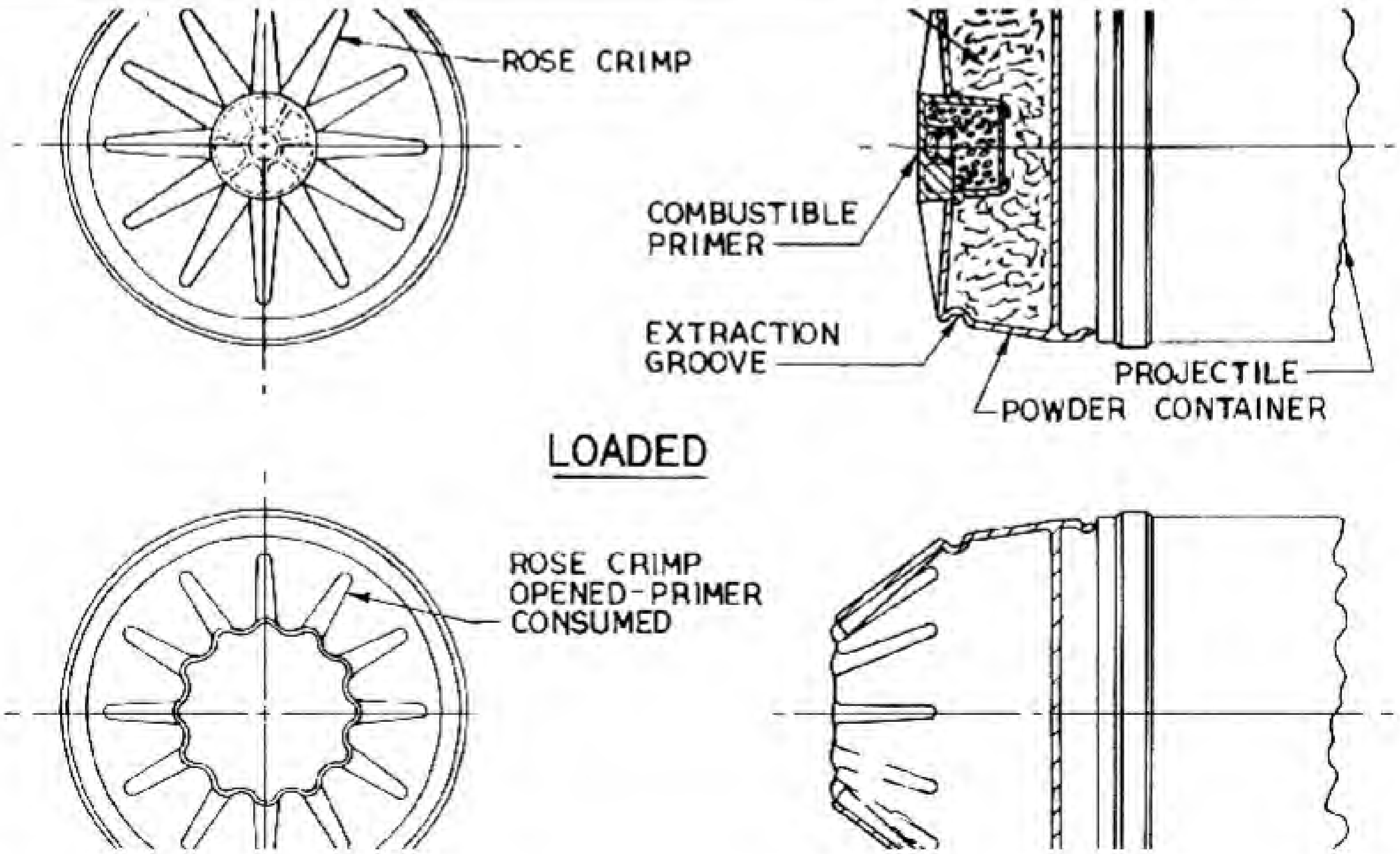
breech block. The camming action also causes ammunition to feed through the clip, and cross feed of the next round is performed with relatively low energy.

Ammunition

In the caseless mono-pressure approach there is a propellant enclosure connected to the projectile. Extraction and ejection are eliminated. The thin-walled enclosure is formed like a boat tail and is permanently attached to the base of the projectile. This chamber provides weatherproofing and integrity of the ammunition during handling and ramming. It also provides an extracting groove for the convenient unloading of chambered rounds. This chamber incorporates a combustible primer/igniter component weather-proofed by sealing with a thin foil of M7 propellant or consumable metal. The caseless high/low cartridge is similarly weather-proofed and protected during handling and ramming by the pressure vessel base. An extracting groove is provided in this base for the convenient unloading of chambered rounds.



High-Low Cased Cartridge


ROSE CRIMP
COMBUSTIBLE PRIMER
EXTRACTION GROOVE
PROJECTILE
POWDER CONTAINER
LOADED
ROSE CRIMP OPENED-PRIMER CONSUMED

PART XVI

AMMUNITION DEVELOPMENT AND UNUSUAL WEAPON CONCEPTS

Chapter 68

AMMUNITION DEVELOPMENT

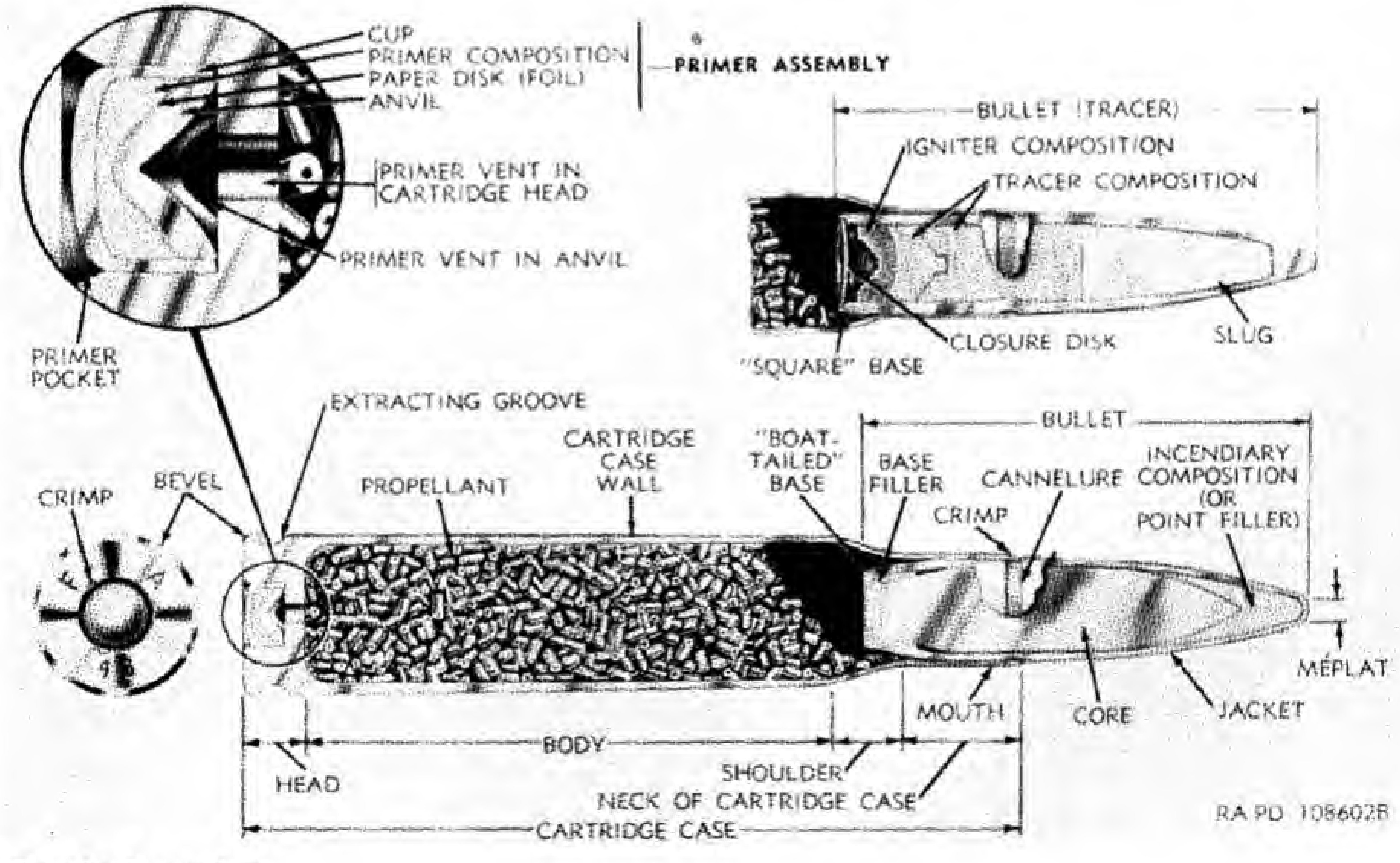
Introduction

In the United States, service ammunition for automatic weapons consists of two classes; but the classification is more for purpose of storage and issue than to emphasize any real difference in design. That used in weapons whose bore is .60 inch or less is classed as small-arms ammunition. A round of small arms ammunition is known as a cartridge. In general, it consists of a bullet, a propelling charge, a primer, and a cartridge case, all assembled into a unit.

Many types of cartridges are manufactured to the same profile. Consequently, cartridges of the same calibre although of different model may be very similar in appearance. Each type, and sometimes each model as in the case of some tracer cartridges, has a characteristic colored bullet tip. Cartridges may be identified as to type, model, and calibre by marking on packing boxes and cartons.

The term "artillery ammunition" refers to ammunition used in weapons having a bore diameter of more than .60 inch. In the United States Naval Service, ammunition in the 20mm to 40mm class is referred to as "minor calibre," which includes present-day automatic cannon ammunition.

A complete round of artillery ammunition comprises all the components necessary to fire the wea-

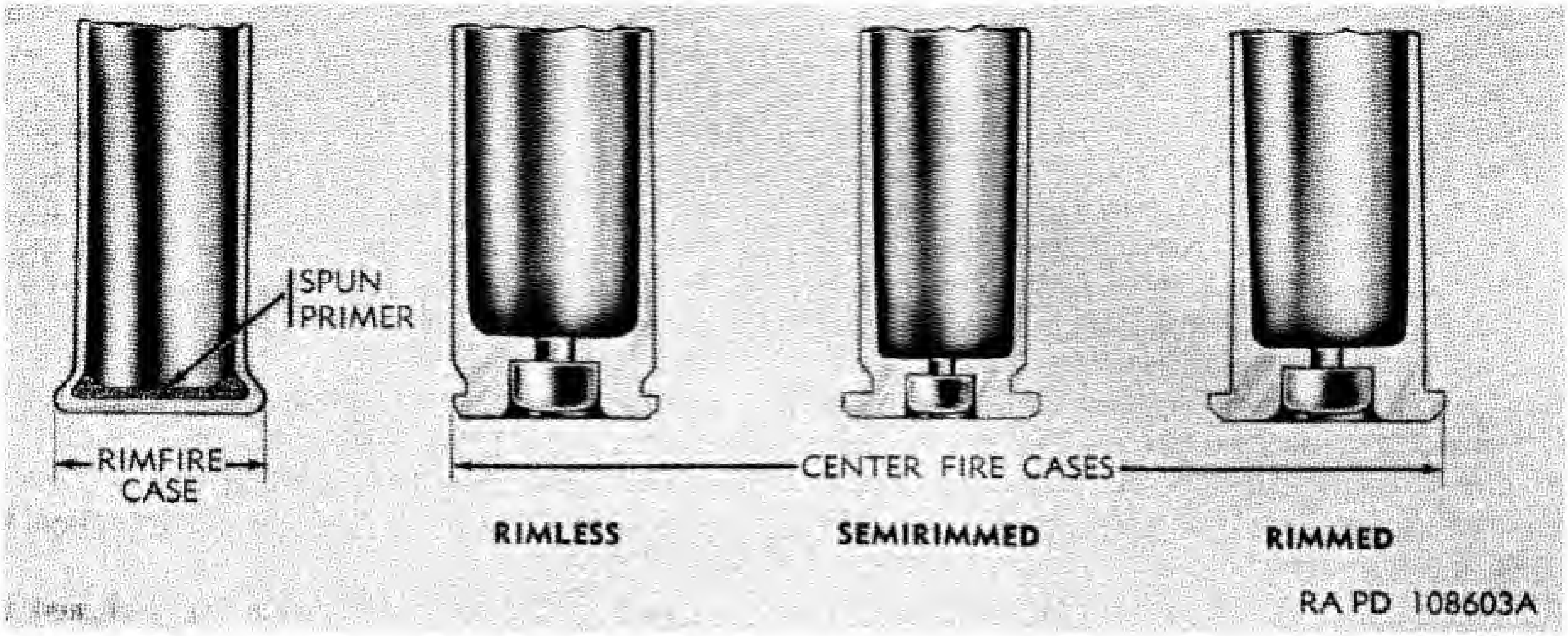

CUP
PRIMER COMPOSITION
PAPER DISK (FOIL)
ANVIL
PRIMER ASSEMBLY
PRIMER VENT IN CARTRIDGE HEAD
PRIMER VENT IN ANVIL
PRIMER POCKET
BULLET (TRACER)
IGNITER COMPOSITION
TRACER COMPOSITION
CLOSURE DISK
SLUG
"SQUARE" BASE
EXTRACTING GROOVE
CARTRIDGE CASE WALL
"BOAT-TAILED" BASE
BULLET
INCENDIARY COMPOSITION (OR POINT FILLER)
CRIMP
BEVEL
PROPELLANT
BASE FILLER
CANNELURE
CRIMP
MEPLAT
MOUTH
CORE
JACKET
BODY
HEAD
SHOULDER
NECK OF CARTRIDGE CASE
CARTRIDGE CASE
RA PD 108602B

Cartridge Terminology

Ammunition Characteristics

CHARACTERISTIC	20-mm		25-mm		30-mm(8)		30-mm(7)	
TYPE	HEI	AP(1)	HEI-T	API(3)	HEI	AP	HEI	API(5)
CARTRIDGE LENGTH (mm)	168	168	219	223	200	200	290	290
CARTRIDGE WEIGHT (grams)	256	256	500	533	496	496	685	702
PROPELLANT WEIGHT (grams)	38	38	90	90	46.5	46.5	152	152
PROJECTILE WEIGHT (grams)	100	100	181	214	270	270	376	393
HEI WEIGHT (grams)	10	—	27	—	48	—	55	—
PENETRATOR WEIGHT (grams)		60(2)	—	148(4)	—	145(2)	—	278(4)
CASE MATERIAL	BRASS/ STEEL	BRASS/ STEEL	STEEL	STEEL	STEEL	STEEL	ALUMINUM	ALUMINUM
SPIN BAND MATERIAL	COPPER	COPPER	IRON	IRON	COPPER	COPPER	PLASTIC	PLASTIC
MUZZLE VELOCITY (m/sec)	1030	1030	1085	1020	719	719	1021	1013
CHAMBER PRESSURE (MPa)	379	379	360	385	276	276	370	400
IMPULSE (Kg-Sec)	15.4	15.4	29.9	31.6	25.0	25.0	54.0	56.3
TIME OF FLIGHT (6) (Sec)								
0.5 km	0.59	0.59	0.52	0.53	0.85	0.85	0.53	0.53
1.5 km	2.93	3.01	2.07	2.05	4.10	4.10	1.92	1.87
2.5 km	7.15	7.33	5.05	4.77	10.00	10.00	4.04	3.81
BALLISTIC DROP (6) (mils)								
0.5 km	2.94	2.95	2.40	2.55	6.14	6.14	2.57	2.58
1.5 km	19.07	20.06	10.67	10.83	39.16	39.16	9.97	9.64
2.5 km	67.46	71.12	32.8	29.89	129.48	129.48	23.14	21.35

(1) M53-NOT IN PRODUCTION
(2) PENETRATOR - STEEL
(3) HONEYWELL (FSD)
(4) STABALLOY
(5) PGU14B - PRODUCTION
(6) GROUND TO AIR (10° ELEVATION)
(7) GAU-8/A
(8) ADEN



Types of Cartridge Cases

pon once and to cause the projectile to function at the desired time and place (blank and drill rounds excepted). Dependent upon both the type of propelling charge and the method of loading into the weapon, complete rounds of artillery ammunition are known as fixed, semi-fixed, or separate loading.

Only fixed ammunition is used in automatic weapons. Fixed ammunition consists of complete rounds in which the propelling charge is fixed that is, not adjustable, and which are loaded into a weapon in one operation. As usually designed, the propelling charge is loose in a cartridge case which is crimped rigidly to the projectile. For certain calibres, rounds of fixed ammunition are termed cartridges. This applies to all 20mm and 40mm rounds, and to some 37mm rounds.

The distinctions between the two classes, small arms and artillery ammunition, was established arbitrarily in the United States Military Service, and in actual practice it is impossible to draw a distinct line between them. Many foreign countries, for example, produce explosive projectiles considerably smaller than .60 inch diameter. The term cannon is generally accepted as common usage for a gun which fires explosive projectiles. But no iron-clad rule exists, and some "machine guns" actually shoot explosive projectiles with fuzes.

Identification of United States Small Arms Ammunition

Ammunition is completely identified, except as to grade, by painting and marking on original packing containers. For purpose of record, the standard nomenclature of the item, together with its lot number, completely identifies the ammunition. Once removed from its packing, ammunition may be identified by the painting and marking on individual items. Other essential information may also be obtained from markings on ammunition items. The muzzle velocity of projectiles may be obtained from the firing tables and ammunition data cards; in the case of some rounds of smaller calibre, the muzzle velocity may appear on the packing box. Included in both the marking and the standard nomenclature are:

1. A brief description of the type or suitable abbreviation thereof;
2. Calibre, weight, or size;
3. Model designation;
4. Where required, such additional information as the model and type of fuze, the model of the cannon in which the item is fired, the weight of projectile for which a separate-loading propelling charge is suited;
5. The lot number is marked on the ammunition but is not a part of the nomenclature. However, when referring to specific ammunition, it is necessary to mention the lot number as well as the standard nomenclature.

Ammunition Lot Number

At the time of manufacture, every item of ammunition is assigned a lot number. Where the size of the item permits, it is marked on the item itself to insure permanency of this means of identification. In addition to this lot number there is assigned to each complete round of fixed and semi-fixed ammunition, an ammunition lot number which serves to identify the conditions under which the round was assembled, and the components used in the assembly. This ammunition lot number is marked on every complete round of fixed and semi-fixed ammunition (except where the item is too small) and on all packing containers. It is required for all purposes of record, including reports on condition, functioning, and accidents, in which the ammunition is involved. As far as practicable, all complete rounds of any particular ammunition lot are made up of components selected from the same lot. To obtain the greatest accuracy in any firing, successive rounds should be from the same ammunition lot.

Manufacturer and Year of Manufacture

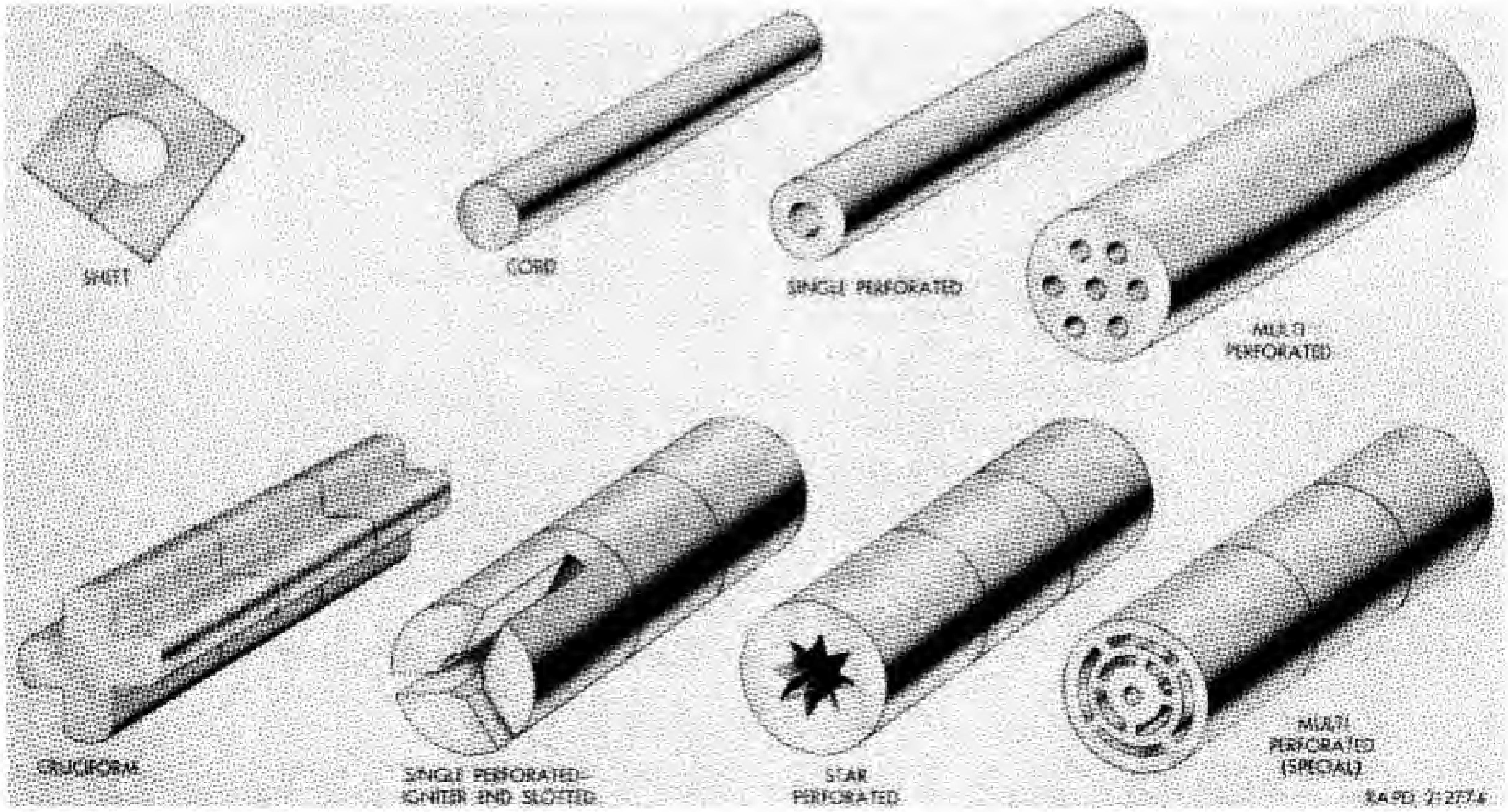
All United States small arms combat ammunition manufactured during World War II, had letters stamped on the head of the cartridge case to indicate the manufacturer and year of manufacture. The following code was used.

Facility	Head Stamp
Allegany Ordnance Plant	KS
Denver Ordnance Plant	DEN
Des Moines Ordnance Plant	DM
Eau Claire Ordnance Plant	EW
Evansville Ordnance Plant	EC
Evansville Ordnance Plant (Sunbeam Division)	ECS
Frankford Arsenal	FA
Kings Mills Ordnance Plant	PC
Lake City Ordnance Plant	LM
Milwaukee Ordnance Plant	M
Remington Arms Company	RA
St. Louis Ordnance Plant	SL
Twin City Ordnance Plant	TW
Utah Ordnance Plant	UT or U
Western Cartridge Company	WCC
Winchester Repeating Arms Company	WRA

Calibre .30 ball ammunition was also manufactured for the Ordnance Department in Canada. Ammunition produced at the Verdun Works was identified by the Head Stamp "VC," and that produced by the Quebec Arsenal was stamped "DAQ."

Ballistically Matched Families

To produce desired effect on the target, various types of projectiles are loaded into the same model cartridge case, thus producing a family of rounds. Because of the varieties available in such a family, ammunition can be loaded in the feed device of automatic guns to produce different effects in the order desired. An attempt is made to keep the projec-



Shapes and Forms of Propellant Grains

tile weight and the external shape of the projectile the same within any given family of rounds. This is done so as to obtain as good ballistic matching as possible between the various members of the family. Such a family is called a "Ballistically Matched Family." By ballistic matching is meant the times of flight are the same and the lines of flight to a predetermined range, usually 1,000 yards, are the same for the various members of the family.

Types of Ammunition used in United States Automatic Weapons

Ball Cartridge. This type of cartridge is the oldest service type. It has been replaced for combat use by other types, but the term has been carried over to describe a type of ammunition now used for training purposes. This ammunition, like the actual "ball" used in old muzzle-loading rifles, has a bullet which lacks special characteristics of material or construction which distinguish newer types. Ball cartridges are assembled with bullets which have lead or mild steel cores.

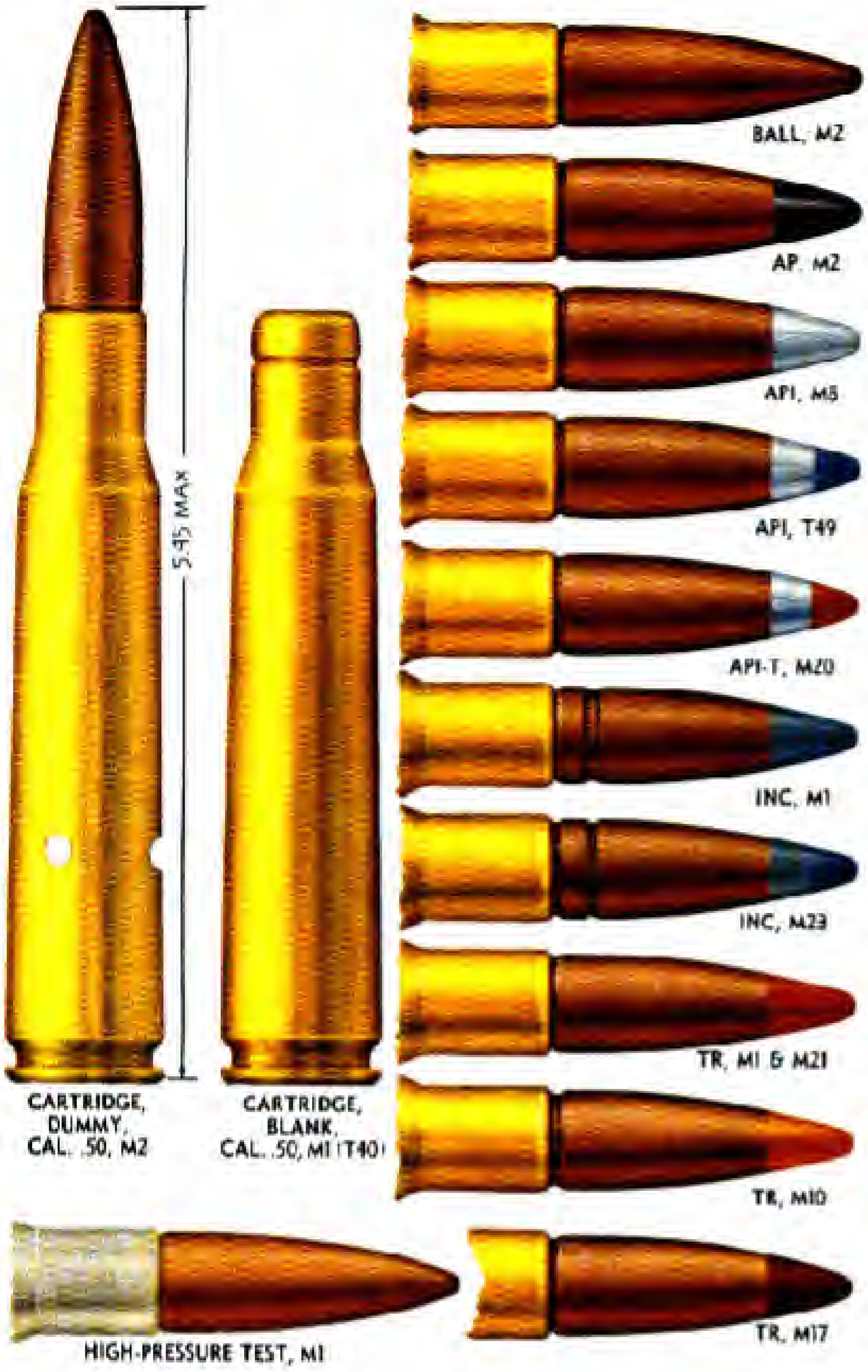
During World War II, the combat use of ball ammunition for calibre .30 weapons continued to decline. The using services expressed a preference for the armor-piercing cartridge which had superior tactical efficiency against lightly armored vehicles, light fortifications, etc., and was much more effective than ball ammunition in jungle warfare. The complexity of manufacture of the armor-piercing cartridge did not permit the achieving of the firing ratio of 80 percent armor-piercing to 20 percent tracer ammunition desired by the Army Ground Forces.

Calibre .50 ball ammunition was not employed in World War II, except at Pearl Harbor and in the fighting in the Philippines in 1941 and 1942.

Armor-Piercing Cartridge. This type of cartridge is intended for use against armored aircraft and vehicles, concrete shelters, and similar bullet-resisting

Color Identification of Small-Arms Cartridges

Color of Tip of Bullet	Type of Cartridge
Black	Armor-piercing, cal. .50, M2, cal. .30, M2, and 7.52mm, M61.
Aluminum color	Armor-piercing-incendiary, cal. .50, M8 and cal. .40, M14.
Red with Aluminum Color Annulus to the Rear	Armor-piercing-incendiary-tracer, cal. .50, M20.
None	Ball, cal. .50, M2 and M33; cal. .45, M1911; cal. .30, M2, carbine, M1; 7.62mm, M59 and M80; cal. .22, M65; and cal. .38, M41.
None (4 holes in cartridge case)	Dummy, cal. .50, M2.
None (fluted case)	Dummy, cal. .30, M40 and 7.62mm, M63.
Green with White Annulus to the Rear (Bullet has mottled appearance)	Frangible, cal. .30, M22.
None (tinned cartridge case)	High-Pressure test, cal. .50, M1; cal. .45, M1; cal. .30, M1; carbine, M18 and 7.62mm, M60.
Light Blue	Incendiary, cal. .50, M1, and cal. .30, M1.
Blue with Light Blue Annulus to the Rear	Incendiary, cal. .50, M23.
Yellow with a Red Annulus to the Rear	Spotter-tracer, cal. .50, M48 and M48A1.
Red	Tracer, cal. .50, M1, headlight, M21, cal. .45, M26, cal. .40, M1, and carbine, M16.
Orange	Tracer, cal. .50, M10, cal. .30, M25, carbine, M27, and 7.62mm, M62.
Brown or Maroon	Tracer, cal. .50, M17.



Calibre .50 Cartridges

targets. The bullet has a hardened steel alloy core. It may have a base filler and a point filler of a softer metal, such as gilding metal.

The development of small-arms armor-piercing cartridges reached a peak during the decade 1930-1940. With the advent of mechanized warfare, the need for bullets with greater lethal effect became apparent. During World War II, the maximum effort was devoted to the development of cartridges possessing lethal qualities, in addition to armor penetration; for example, armor-piercing-incendiary and armor-piercing-tracer cartridges. The need for such ammunition was recognized by all nations engaged in the conflict, and the use of cartridges whose sole characteristics was penetration decreased considerably.

Armor-Piercing Incendiary Cartridge (AP-I). This type of cartridge is used in lieu of both armor-piercing and incendiary cartridges.

Armor-Piercing Incendiary Cartridge Mk 107 Mod 0. Armor-piercing incendiary (AP-I) have solid projectile bodies machined from steel. The ogive is sharply rounded to a short blunt nose. This shape increases the ability of the projectile to penetrate armor instead of richocheting. A steel adapter (false ogive) and an aluminum nose-piece containing an incendiary filler added to this projectile body give it the conventional length and contour. The incendiary charge is designed to ignite upon impact with the target to set fire to combustible materials (fuel, etc.) and does not detonate. AP-I projectiles have no fuzes or tracers. The projectile body with assembled nosepiece and adapter is designated Mk 13 Mod 0.

AP-I rounds have no fuzes and the nose portion of the projectile is painted blue. The body of the projectile is black and lettering is white with lot prefix "ZR."

Armor-Piercing Incendiary Tracer Cartridge (AP-IT). This type of cartridge combines the features of armor-piercing, of incendiary, and of tracer cartridge and is intended to replace these cartridges.

Armor-Piercing Tracer Cartridge Mk 108 Mod 0. Armor-piercing tracer (AP-T) cartridges are similar to AP-I cartridges except that a cavity is machined in the back of the projectile body to receiver a tracer mixture and instead of a false ogive and loaded nosepiece. A hollow windshield is used to bring the stubby projectile body up to standard length and contour. The windshield folds back when the projectile strikes the target and acts as a guide to prevent ricocheting off the target. AP cartridges do not have fuzes. The tracer charge is ignited by the heat of the propellant. The projectile body with assembled windshield is designated Mk 14 Mod 0.

AP-T cartridges have no fuzes and the nose portion of the projectile is painted yellow. The body of the projectile is painted black and lettering is white with the lot prefix "ZT."

Incendiary Cartridge. This type of cartridge is similar to ball or armor-piercing ammunition in outward appearance. It is used for incendiary purposes against aircraft. It contains an incendiary composition as a central bullet core, which ignites on impact with the target.

Blank Cartridge. This type of cartridge is distinguished by the absence of a bullet. It is used for simulated fire, training cavalry mounts, and firing salutes. It is also used in machine guns equipped with blank-firing attachments in order to operate these weapons, for instructional purposes. EC blank powder is used to produce the noise. Special types of blank cartridges with heavy powder charges are used by foot-troops to launch anti-tank missiles from shoulder weapons. These are officially called "grenade cartridges."

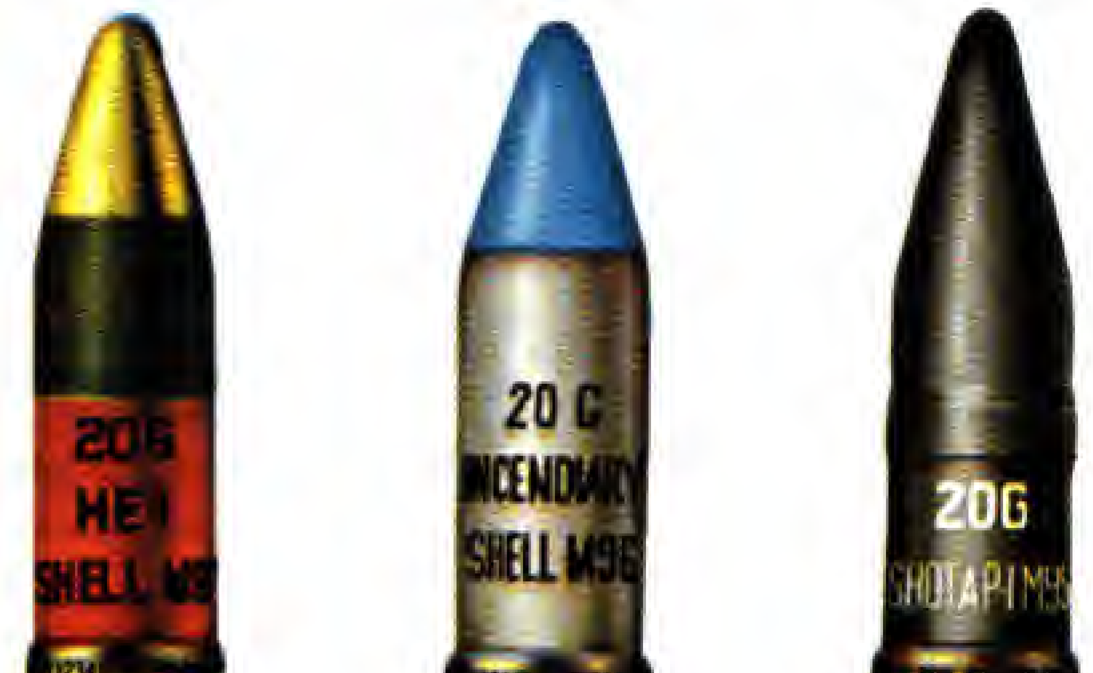
In general, European practice in blank fire has been to employ cartridges assembled with wood bullets and with a muzzle reducer to break up the bullet after passage through the barrel. In this connection it was reported that during the operations in Germany, the Germans tactically employed cartridges with wood bullets as follows: After pinning down attacking personnel with combat ammunition, the German machine gunners continued fire with blank cartridges, which permitted German soldiers to approach and attach the positions of the enemy, before the latter became aware that the standard round was not being fired.

The standard blank ammunition used by the United States Armed Forces is similar in appearance to grenade cartridges, but is loaded with E.C. blank fire powder, which is a mixture of guncotton and inorganic nitrates. The powder resembles sand. It is sensitive to friction shock and heat. The initials E.C. represent the name of the company, the Explosives Company, which originally developed the powder.

During World War II, when brass was a critical material, steel cartridge cases were approved for use with blank cartridges.

Tracer Cartridge. This type of cartridge is intended for use with other types to show the gunner, by its trace, the path of the bullets, thus assisting in correcting aim. It may also be used for incendiary purposes. The tracer element consists of a pressed inflammable material in the base of the bullet; this composition is ignited by the propelling charge when the cartridge is fired.

A tracer bullet is defined as one whose trajectory is rendered visible by the incorporation of a chemical element which leaves a trail of flame and/or smoke. Because of the instability in storage of the finely divided metals, peroxides, and nitrates employed in tracer and igniter compositions, this type of bullet has caused considerable concern to military powers since it was first used in modern warfare. Further, so far as the United States has been concerned, the using services have seldom agreed on the nature of the luminous element, its brightness, color, and length of trace. During World War II, the lack of agreement resulted in the expenditure of considerable funds and technical effort to produce a large number of types, many of which were not adopted for combat purposes.

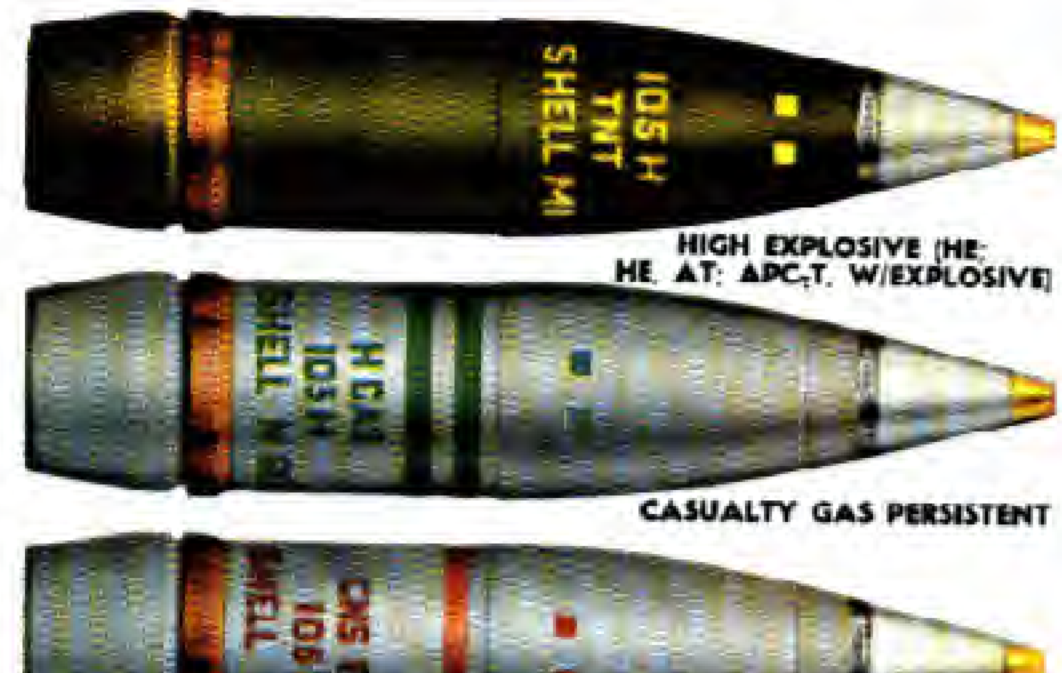


RA PD. 167577A

Color Identification and Typical Marking of Cartridges for Aircraft Cannon

High-Pressure Test Cartridge. This type of cartridge is manufactured for use in proof firing of small arms. Since the propelling charge of this ammunition develops high pressures, these cartridges should never be used for any other purpose. When used for the purpose intended, all personnel should be protected by adequate cover. This ammunition is distinguished from other types by the tin coating of the cartridge case. In some older lots, the word "TEST" is stamped on the head of the case.

High Pressure Test Cartridge Mk 101 Mod 0 and Low Pressure Test Cartridge Mk 102 Mod 0. High pressure test (HPT) and low pressure test (LPT) cartridges used primarily for testing new production of Guns Mk 12. The projectiles contain no explosive charge.


105 H
TNT
SHELL M1
HIGH EXPLOSIVE (HE; HE, AT; APC-T, W/EXPLOSIVE)
CASUALTY GAS PERSISTENT
TRAINING AND RIOT CONTROL GAS
SMOKE
ILLUMINATING
PRACTICE
INERT (HVAP-T; DUMMY; AP-T; APC-T, W/O EXPLOSIVE)
RA PD 97767C

Color Identification and Typical Marking of Artillery Projectiles

The Projectile Mk 11 Mod 0 of the HPT round is loaded with cast or powdered lead. The Projectile Mk 12 Mod 0 of the LPT round has no filler. Both types use Electric Primer Mk 47 Mod 0.

HPT and LPT cartridges have green projectiles with lettering in black. These cartridges are also marked on the cartridge case with 1/4-inch black letters reading, "High pressure (or low pressure) test cartridge." Lot prefix letters are not assigned to this type of cartridge, because of their limited issue and special use.

Dummy Cartridge. This type of cartridge is used for practice in loading weapons, to detect flinching in firing weapons, and to simulate firing. The present means of identification of dummy cartridges is by means of holes drilled through the side of the case and by the empty primer hole. The cartridges are completely inert but simulate service rounds in most details. Dummy cartridges have brown projectiles and the lettering is white.

High-Explosive (HE) Shell. This projectile, made of common forged steel, has comparatively thin walls and a large bursting charge of high explosive. It is used against personnel and material targets, producing blast and/or mining effect and fragmentation at the target. It may be fitted with either a time or impact fuze, or a concrete-piercing fuze, depending on the type of action desired. HE-1 shells have unpainted fuzes. The ogive portion of the projectile is yellow and the remainder of the body is red. Lettering is black and the lot prefix is "ZQ."

Target Practice (TP). Cast-iron shot and sand-loaded shell of the same size, shape, and weight as the service shell it simulates are provided for target practice. Some models may have a small quantity of black powder to serve as a spotting charge.

Target Practice Cartridge Mk 105 Mod 0. Target practice (TP) cartridges have no explosive filler in the Projectile Mk 11 Mod 0. A dummy nose plug is used in place of a fuze.

TP cartridges have green projectiles with lettering in black. The lot number will have a "ZS" prefix.

Dummy Cartridge Mk 103 Mod 0 and Mk 104 Mod 0. Dummy cartridges contain no explosive charge in either the projectile or the cartridge case and are used for loading practice, belting practice, function testing of feed mechanisms, etc. The cartridge case for the Dummy Cartridge Mk 103 is either manufactured for the purpose, in which case there is no primer cavity, or, for alternate assembly, cartridge cases rejected for service because of minor imperfections may have been used. These will have primer holes plugged with brass plugs or empty primer cups staked in place with three crimps equally spaced. In either assembly, the cartridge case is loaded with inert material to bring it up to standard weight and is crimped to a Projectile Mk 11 Mod 0 in the conventional manner.

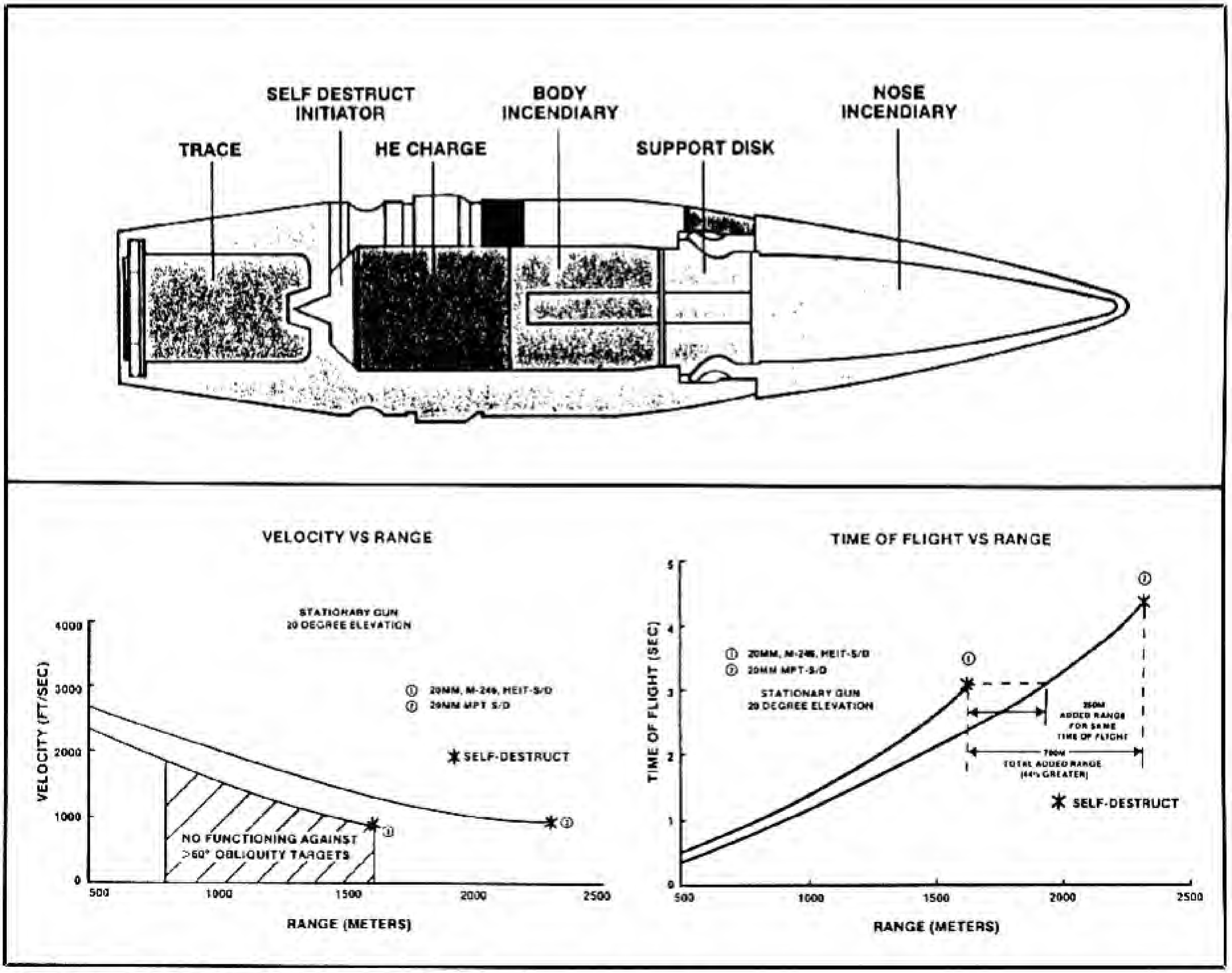
The Dummy Cartridge Mk 104 does not have separate cartridge case and projectile, but is machined in one hollow cylindrical piece requiring only the addition of nose plug and base plug to make a complete unit. No loading with inert material is required.

Firing Circuit Test Cartridge Mk 109 Mod 0. Firing circuit test cartridges are used whenever it is required to establish that the gun firing circuit is functioning. The cartridge is comprised of a cartridge case and a primer of the same design as used in regular ammunition, but has no propellent or projectile. The explosion of the primer, when the gun firing circuit is closed, is sufficient to indicate that the circuit is operating properly. Cartridge cases rejected for service use, because of imperfections in the metal, or primed cases obtained from breakdown of service cartridges, may be used for the firing circuit test cartridge. This item is unclassified and is suitable for training or service use.

Calibre .50 Ammunition. In April 1918, the American Expeditionary Forces expressed an urgent requirement for a high-powered, large-calibre machine gun and ammunition primarily for aircraft, with second priority for ground use. In May the specifications were expanded to include a round having a muzzle velocity of 2,600 feet per second and a bullet of a weight that would be accurate and effective at ranges up to 600 meters.

Available knowledge on the performance of a German 13.2mm rimmed antitank cartridge, as well as information on the British development of a calibre .50 cartridge, led to a decision to develop a calibre .50 machine gun and suitable ammunition. Guns were designed under the supervision of John Browning at the Colt's Patent Fire Arms Company (ground type), and the Winchester Repeating Arms Company was requested to develop suitable calibre .50 ammunition for the machine gun under the following specifications: 500-grain bullet; muzzle velocity of 3,000 feet per second; and rimless cartridge case.

Early in May 1918, the first calibre .50 cartridges were fired for ballistic performance at New Haven, Connecticut. Firings were conducted with both 707- and 505-grain bullets loaded in rimmed cases. These


SELF DESTRUCT INITIATOR
BODY INCENDIARY
NOSE INCENDIARY
TRACE
HE CHARGE
SUPPORT DISK
VELOCITY VS RANGE
STATIONARY GUN
20 DEGREE ELEVATION
① 20MM, M-246, HEIT-S/D
② 20MM MPT S/D
✱ SELF-DESTRUCT
NO FUNCTIONING AGAINST >60° OBLIQUITY TARGETS
VELOCITY (FT/SEC)
0
1000
2000
3000
4000
500
1000
1500
2000
2500
RANGE (METERS)
TIME OF FLIGHT VS RANGE
① 20MM, M-246, HEIT-S/D
② 20MM MPT-S/D
STATIONARY GUN
20 DEGREE ELEVATION
300M
ADDED RANGE
FOR SAME
TIME OF FLIGHT
700M
TOTAL ADDED RANGE
(44% GREATER)
✱ SELF-DESTRUCT
TIME OF FLIGHT (SEC)
0
1
2
3
4
5
500
1000
1500
2000
2500
RANGE (METERS)

Olin Corporation's 20mm Multi-Purpose Traced Self-Destruct Projectile yielded velocities at 50 feet of 2,596 and 3,023 feet per second, respectively. The 707-grain bullet was propelled by 160 grains of IMR 13 powder; 170 grains of the same propellant were used with the 505-grain bullet. A 10-grain black powder booster was used. The bullets had cupronickel jackets and lead cores.

During the period May 1918 to November 1918, experiments were conducted with varying weight bullets, and attempts were made to improve the cartridge case.

In November 1918, with the termination of hostilities, the development of ammunition was transferred to Frankford Arsenal. That station developed a semi-rimless cartridge case and later, in 1919, a rimless cartridge case. When machine guns became available for automatic firings, it was found that the lead-cored ball ammunition keyholed and was unsatisfactory.

When a firm requirement for calibre .50 ball ammunition was established in 1921, by the Chief of Coast Artillery and the Chief of Air Service, a cartridge assembled with a steel-cored, gilding-metal jacketed bullet weighing 791 grains was developed and adopted as Standard in 1923. The item, assigned the nomenclature Cartridge, Ball, Calibre .50, M1923, was loaded to an instrumental velocity of 2,370 feet per second at 78 feet in a 45-inch barrel. A heavy bullet was used to obtain maximum penetration at long range.

Development work continued in view of service reports that the accuracy of the calibre .50 cartridge M1923 was not entirely satisfactory. In October 1929, Cartridge, Ball, Calibre .50, T2E13, assembled with a 750-grain bullet loaded to an instrumental velocity of 2,500 feet per second at 78 feet in a 45-inch barrel, was adopted as standard and assigned the nomenclature Cartridge, Ball, Calibre .50, M1.

In May 1932, consideration was given to the practicability of raising the chamber pressure of calibre .50 ammunition from 48,000 p.s.i. to 50,000 p.s.i. By 1937, improvements in powder and information from extended machine gun firings permitted a change in instrumental velocity to 2,700 feet per second in a 36-inch barrel with a mean pressure which did not exceed 50,000 p.s.i.

Improvements in calibre .50 armor-piercing ammunition necessitated changes in design of the calibre .50 ball bullet. Since the latter was used in training, it was mandatory that the ball and armor-piercing bullets have matching ballistic characteristics. The most satisfactory armor-piercing was obtained with a 711-grain armor-piercing bullet (M2) and simultaneously with the adoption of this round, the Ordnance Committee provided for the standardization of a ball round identical in physical characteristics, except that mild steel cores were to be used. The nomenclature assigned was Cartridge, Ball, Calibre .50, M2. The established instrumental velocity at 78 feet in a 36-inch barrel was 2,800 + 30 feet per second; in a 45-inch barrel, the velocity was 2,900 + 30 feet per second at 78 feet.

With the adoption of the calibre .50, M2 ball cartridge on 20 February 1941, the M1 was reclassified as Limited Standard.

Sporadic attempts were made throughout the development of calibre .50 ball cartridges to eliminate the steel core, which required critical screw machines for its manufacture. None of the proposed substitutes was satisfactory when fired in hot and/or worn barrels.

On 7 October 1943, Cartridge, Ball, Calibre .50, M1 and Cartridge, Ball, Calibre .50, M1923 were reclassified as obsolete by the Ordnance Committee.

Calibre 20/.50 Ammunition. Early in 1942, a project was initiated at Frankford Arsenal to develop a calibre .50 test barrel and round which would have the 20mm brass cartridge case necked down to accommodate standard calibre .50 projectiles.

A barrel 53⅛ inches long was constructed by joining sections of standard 45-inch calibre .50 barrels and chambered for 20mm brass cases necked down to calibre .50. The standard calibre .50 armor-piercing M2 bullets weighing 710 grains were used in the test. Velocities approximating 4,000 feet per second at 78 feet, at a maximum pressure of 57,000 p.s.i. were obtained. No evidence of straining of the jackets was found in the firing of 27 rounds. Recovered bullets indicated satisfactory engraving of the rifling and no jacket deformation attributable to rotational spin. The high-velocity ammunition perforated 1¼ inch and 1½ inch homogeneous (375 Brinell) plate, with normal impact at 100 yards and was superior to standard .50 calibre ammunition in this respect.

The project was discontinued, precedence being given to the development of calibre .60 ammunition.

Origin of the Calibre .60 Round. On 11 January 1939, the Ordnance Committee established a requirement for the development of an anti-tank rifle to fire a bullet which would penetrate a minimum of 1.25 inches of armor plate at normal impact at 500 yards range. Based on information obtained from abroad and study of data obtained in the acceptance test of light armor at Aberdeen Proving Ground, a series of computations were made to determine as nearly as possible the expected performance of various calibres within the limits of calibre .50 to calibre .80. It was found that a calibre .60 cartridge with the following basic characteristics, was the lightest that could be expected to meet the penetration requirements:

Calibre	0.60 inch
Weight of Bullet	1,200 grains
Muzzle Velocity	3,420 feet per second
Remaining Velocity at 500 Yards	2,850 feet per second

The requirement was formally established by the Ordnance Committee on 7 February 1939.

Frankford Arsenal and Aberdeen Proving Ground were requested to make a study of a complete round with these characteristics and to furnish a suggested design. A contract was negotiated with the Winchester Repeating Arms Company, to develop a calibre .60 complete round, which would satisfy the requirements and to manufacture Mann-type barrels for testing the rounds.

The performance of the Winchester ammunition was unsatisfactory. Erratic flight of the bullet resulted in failure to penetrate armor plate to 1.25 inches at 100 yards. Examination of recovered bullets revealed uneven engraving of rifling. The bullet was so unstable, that in the majority of cases it was not accurate at ranges as short as 50 feet. On completion of the Winchester Repeating Arms Company contract in September 1940, the project was transferred to the Frankford Arsenal Ordnance Laboratory.

On 22 May 1941, the Ordnance Committee approved the development of a calibre .60 aircraft machine gun. In October 1942, the Army Air Forces reiterated interest in the development of the aircraft machine gun and requested three test models. On 27 October 1942, a conference was held at Frankfort Arsenal to initiate the development and manufacture of armor-piercing and tracer ammunition for the calibre .60 anti-tank rifle and aircraft machine gun.

On 22 May 1943, the requirement for the calibre .60 anti-tank rifle was terminated by the Ordnance Committee because of the relative ineffectiveness of such ammunition against the new types of heavily armored enemy vehicles. Development of calibre .60 ammunition for the aircraft machine gun continued. By 2 December 1943, ball, armor-piercing, incendiary, and armor-piercing-tracer ammunition had been developed.

In the initial development of calibre .60 ammunition, primary consideration was given to the armor-piercing cartridge. A duplicate round, with a mild steel core in place of a hardened steel core, was considered for training purposes. In the course of development work on the armor-piercing bullet, it seemed advisable to develop base-capped bullets with the bare steel cores. Mild steel cores were used for tests to determine bullet stability.

As originally conceived, the calibre .60 cartridge case represented, with minor dimensional differences, an expansion of the calibre .276 cartridge case developed during the period 1925-1929.

The imminent production of ammunition on a relatively large scale in December 1943, as well as attempts to increase barrel life by increasing the depth of rifling, led to the development and testing of a number of modifications of the original cartridge case. The modifications are listed in the following table, together with the designations assigned to them.

Model of Case	Description
T1	Original cartridge case (drawing BLX-H2-10) with 0.050 inch per inch body taper.
T1E1	T1 modified for deep rifling (groove diameter 0.606 inch).
T1E2	T1 with thick neck (0.030 inch).
T1E3	T1E1 with thick neck (0.30 inch).
T2	T1 case with body taper of 0.35 inch per inch (drawing BLX-H2-22).
T2E1	T2 modified for 0.606-inch groove diameter.
T2E2	T2 with thick neck (0.030 inch).
T2E3	T2E1 case with thick neck (0.030 inch).

When a groove diameter of 0.604 inch was adopted, a case designated as the T2E4 was developed and tested. This case had a body taper of 0.035 inch per inch, a thick neck (0.030 inch) and was adapted to the 0.604-inch groove diameter.

The T2E4 cartridge case, as a result of successful firing at Aberdeen Proving Ground, Frankford Arsenal, and the St. Louis Ordnance Plant, was adopted for mass production. All production ammunition was assembled with this case.

Calibre .60/.50 Ammunition. On 23 February 1944, Frankford Arsenal was directed to prepare chamber and case drawings for a calibre .60 cartridge case, necked down to calibre .50 and designed to accommodate the standard calibre .50 projectile. On 27 April 1944, Springfield Armory was directed to manufacture three test barrels and two machine gun barrels in accordance with drawings which had been prepared by the Arsenal.

Initial tests at the Arsenal with the calibre .50 armor-piercing incendiary, M8 bullet gave an average velocity of 3,937 feet per second at 78 feet with a chamber pressure of 65,500 p.s.i. Samples of the ammunition designated as Cartridge, Armor-Piercing Incendiary, Calibre .60/.50, T51, were forwarded to Aberdeen Proving Ground for ballistics tests. The time of flight of the T51 projectile to 1,000 yards was .94 second at a recorded velocity of 3,988 feet per second. In machine gun firings in steel barrels, keyholding and tipping occurred in the first 10 rounds of the burst. Accordingly, arrangements were immediately made for the procurement of calibre .60/.50 barrels with stellite liners as well as barrels with a twist of one turn in 20 inches.

The barrels with one turn in 20 inches gave a high percent of tips and keyholes in each ten-round burst. Similar performance was encountered with the stellite-lined barrels.

On 14 April 1945, Frankford Arsenal assembled and forwarded to Aberdeen Proving Ground 100 calibre .60/.50 cartridges assembled with the 500-grain T49 armor-piercing incendiary projectile. In Frankford Arsenal ballistic tests, a velocity at 78 feet of 4,451 feet per second was obtained with a pressure of 57,560 p.s.i. Six hundred fifteen grains of IMR 4996 powder were used. The air space was approximately .61 inch.

The round, designated as Cartridge, Armor-Piercing Incendiary, Calibre .60/.50, T75, was fired at Aberdeen Proving Ground in a T17E3 machine gun assembled with a stellite-lined barrel.

The 27mm Round (26.7mm). In a study by the Ballistic Research Laboratory, Aberdeen Proving Ground, it was determined that the optimum calibre for a bomber tail-defense weapon is 25mm to 30mm for proper HE volume. In attempting to meet this requirement, it was decided to supply conversion kits for two guns already under development and firing the normal calibre .60 round. The largest projectile which can be loaded into the calibre .60 case approximates 26.7mm. Since use of this projectile eliminates the shoulder of the case, a flange is added, just in front of the cannelure.

20mm High Capacity Cases T5 and T7. In response to demands for improved armor penetration by aircraft guns, the Ordnance Department designed a new case for use with 20mm projectiles. Preliminary firings indicated that a muzzle velocity of 3,500 feet per second could be attained using a barrel 78 inches long. Using the standard 20mm armor-piercing projectile, one-inch plates of face-hardened armor were penetrated at 200 yards, normal impact.

The T5 case was not extensively used. After the war, when certain German mechanisms were being further developed in this country the 20mm German case for the MG 213 was copied and designated the T7 case. Thereafter, to reduce the number of varieties of ammunition, the several projects using the T5 case were converted to use the T7. (There were proposals to load the 27mm projectile into the T7 case.)

Loading, Assembly, and Acceptance Procedures for United States Automatic Weapon Ammunition

Powder Acceptance Procedure. In addition to chemical analysis, measurements of heat of explosion (burning), grain length, diameter, and web size, acceptance is ultimately based on performance in ammunition. This latter quality is determined by pressure and velocity firings of loaded ammunition from Mann Accuracy Actions. Ammunition for this test is assembled from carefully selected "reference" components, the weights and dimensional tolerances of which are closely controlled. A "standard" charge (for instance, 650 grains) of powder to be accepted is hand-weighed and loaded into the primed cartridge cases, which have been previously drilled for pressure gage readings. In order to be accepted, the "reference ammunition," must give pressures and velocities which are within prescribed limits for the weight of charge specified.

Ammunition Loading, Assembly and Testing. Loading and assembly of ammunition is conducted at the ammunition depot or loading plant. The quantities of aircraft ammunition loaded during periods of war or "police action," make automatic loading equipment mandatory.

Ammunition is generally loaded and assembled in lots of 50,000 cartridges from lots of 50,000 of each component and from one powder lot.

At the start of loading, a "charge" determination must be made to determine the correct weight of propellant powder for the particular ammunition components to be used. The charge determination is made by loading a predetermined number of rounds of ammunition (for instance, 10) with each of three arbitrarily determined charge weights of the powder to be used in loading the ammunition lot. Other components for this test are selected at random from those to be used in assembly of the ammunition lot. Assume that ten rounds of ammunition are loaded with each of the following weights of propellant: 620 grains, 640 grains, and 660 grains.

These cartridges are fired in test (Mann) actions, and pressures and velocities recorded for the single shot firings. The average pressures and velocities for each charge group are plotted against the weight of charge, and the correct weight of charge to give specified pressure and velocity for the lot of ammunition is determined from the resulting graph.

Having determined the charge to be used, the automatic loading equipment is adjusted to deliver volumetrically this weight of charge (650 grains) within or - 6 grains and loading may proceed. Assuming that the weight was determined to be 650 grains, the accompanying flow chart suggests applicable loading operation.

(1) Continuous inspection should be made during loading and assembly, as well as sampling inspection of the assembled lot. In addition to 100 percent gaging inspection, which may be performed by machine, samples must be fired single-shot from test actions for check on velocity, pressure and accuracy, and from automatic guns as a check on functioning under service conditions.

Target practice projectiles may be assembled at the loading and assembly plant and the nose pieces stacked in place at this time.

In addition to acceptance at the loading plant, it is generally required that final acceptance of a lot of ammunition is based on proving ground firing tests.

It may also be noted that the ambient temperature of the ammunition has a marked effect upon its performance. Range table velocities are usually computed on the basis of ammunition at 70 degrees F. However, each degree above or below this value results in a change of velocity of about 1.2 feet per second.

The evaluation of service weapons under extreme conditions, has led to the development of high-pressure-test (HPT) and low-pressure-test (LPT) ammunition. These two variations were designed to duplicate the pressures and velocities which exist at 165 degrees F and -65 degrees F, respectively. If a maximum pressure of 58,000 p.s.i. is assumed, the powder pressure will be as follows:

HPT: 12% of Std.
(1.2 x 58,000)
69,600 p.s.i.
LPT: 88% of Std.
(.88 x 58,000)
51,400 p.s.i.

It might also be well to note at this point that the powder is subject to "cook-off." This is to say, if the powder is subjected to elevated temperatures for an extended period of time, a spontaneous detonation will occur. This is the case when a loaded round is chambered in a hot barrel. Anytime a round is chambered after 150 rounds have been fired in a continuous burst, a "cook-off" may be expected. Either the primer or the propellant may "cook-off," but most frequently, the propellant goes first, due to the large area of the cartridge case being in contact with the powder. If a "cook-off" occurs when the bolt is unlocked, personnel are in danger.

An equally dangerous condition may result if an unfired round fails to extract when the charger is activated. The bolt, in returning to battery, tries to chamber a second round, resulting in a double feed. There is a chance that the nose of the second round may indent the primer of the chambered round and cause an explosion with an unlocked gun. Even though the M52A3 primer is normally electric fired, it is subject to percussion ignition as caused by double feeds.

Madsen 23mm Ammunition

The Madsen 20mm ammunition was developed by the Kynoch Co. of England, a subsidiary of Emperial Chemical Industries, Ltd. The first attempts starting about 1925, are reported to include a rim; however, when the gun and ammunition were actually sold commercially, the case was rimless. Madsen turned the entire development work over to Kynoch.

The 23mm Madsen cartridge was made by simply enlarging the neck of the 20mm case. Since the original case had very little shoulder, it was difficult to maintain the shoulder-to-head distance during manufacture in quantity. The resulting variation resulted in misfires when the case entered the chamber too far and the firing pin did not ignite the cap. It became necessary to modify the gun to stop the round from moving too far in the chamber.

The advantage of the 23mm projectile over the 20mm is that with an increase of only 3mm in diameter, twice the explosive charge can be carried. Despite this advantage, Russia was the only major power to adopt the 23mm projectiles.

German Ammunition

German standard automatic ammunition consists of three general designs: Mauser, Oerlikon, and Rheinmetall. The Mauser type cartridge cases are derived from the cartridge of the German infantry rifle, which also is the basis for the design of the American Infantry cartridge of 1906.

The Oerlikon round has the typical reduced rim and slight neck of that family.

The Rheinmetall cartridges are of distinctive design and feature the flange just forward of the cannelure. However, when Rheinmetall began producing the blow-back type gun, it copied the Oerlikon type case.

20mm Ammunition. The 20mm Mauser cartridge consists of the case of the 15mm cartridge enlarged to hold the 20mm projectile. Other than the neck diameter, all dimensions are the same.

The 20mm Oerlikon round used in the aircraft gun features a case only 3.15 inches long. The same projectiles are used in the 20mm Mauser and Oerlikon cases.

The 20mm Oerlikon anti-aircraft gun FLAK 28 uses a long round with the case length of 4.29 inches. This round apparently interchanges with the American and British Naval anti-aircraft round.

The 20mm Rheinmetall cartridge is used in the German Flak 30 cannon. In Italy, this ammunition is called Breda. The earlier types of Solothurn one-man semi-automatic, anti-tank gun used a shorter cartridge case.

30mm Ammunition. The 30mm Rheinmetall cannon Mk 101 and Mk 103, used a cartridge case about seven inches long, tapered, with a prominent neck and a flange in front of the cannelure. With the appearance of the Mk 108, there was adopted a 30mm short case about three inches long, with a reduced rim and very slight taper.

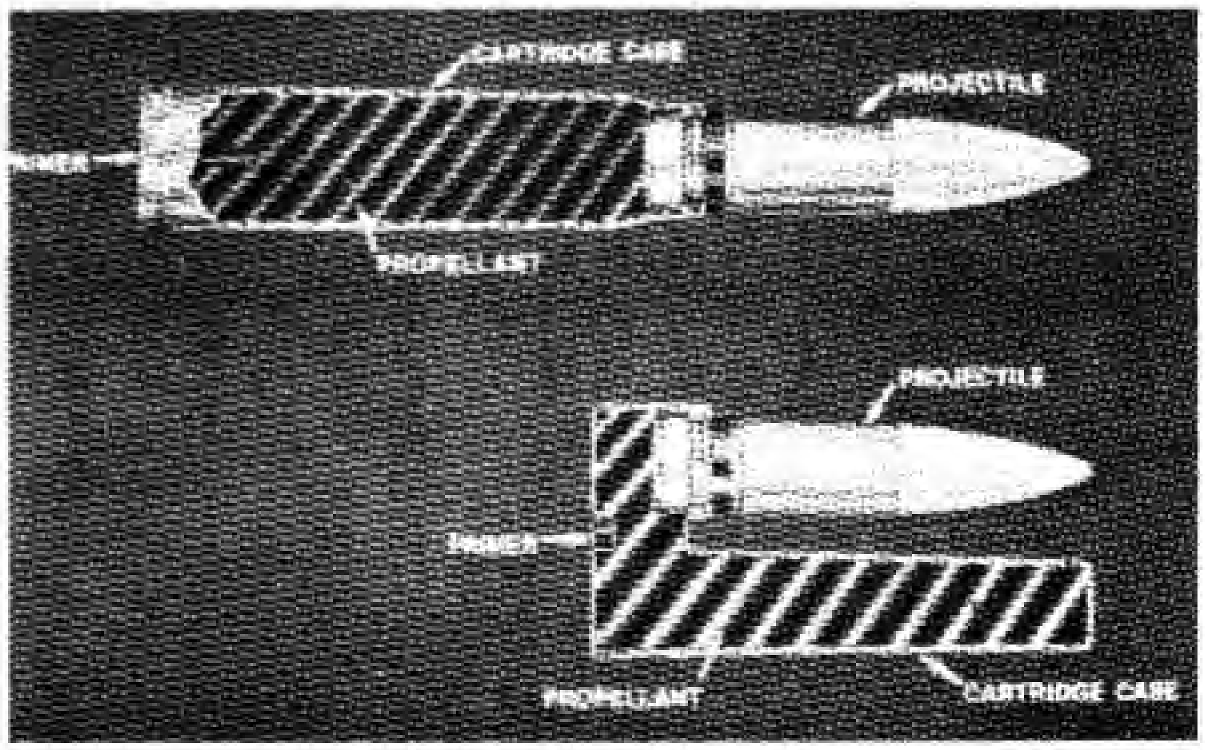
SECTION I.

UNUSUAL AMMUNITION CONCEPTS, EXPERIMENTATIONS AND TESTS

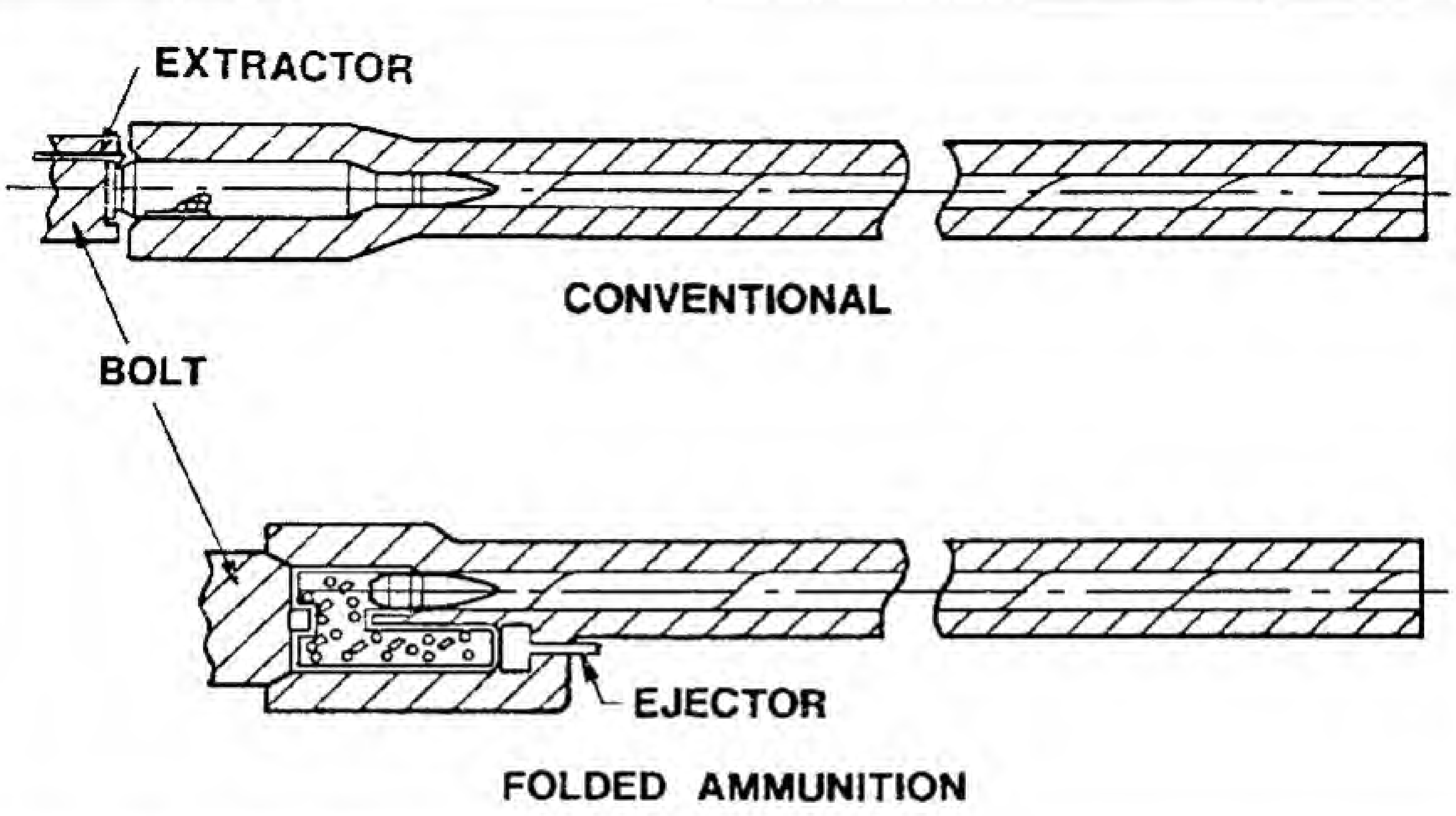
Folded Ammunition

Within the gun armaments community in recent times, there has been a noticeable trend to depart from the classical, "bottleneck" type configuration of ammunition. These new trends include, in addition to the otherwise familiar liquid propellant and caseless systems, such concepts as cased-telescoped (both rectangularly and cylindrically shaped), separate loading ammunition and folded ammunition.

Folded ammunition is a unique design in which the propellant charge is relocated from a position behind and coaxial with the projectile to one beside the projectile. Although the feasibility of folded ammunition was demonstrated with small-calibre ammuni-



Comparison of Conventional and Folded Cartridges



Ammunition/Weapon System Comparison

tion as the test vehicle, the design was to achieve a weapon system which was qualitatively superior to those attainable with conventional approaches. The following claims were made:

1. More efficient use of space in the stowage of ammunition in vehicles or aircraft or in association with the weapon and its accessories.
2. Accommodation of increasingly higher performance projectiles wherein excessive cartridge length presently creates serious system space problems when conventional ammunition design is used.
3. Reduction in system weight.
4. Cost-effective logistic deployment.

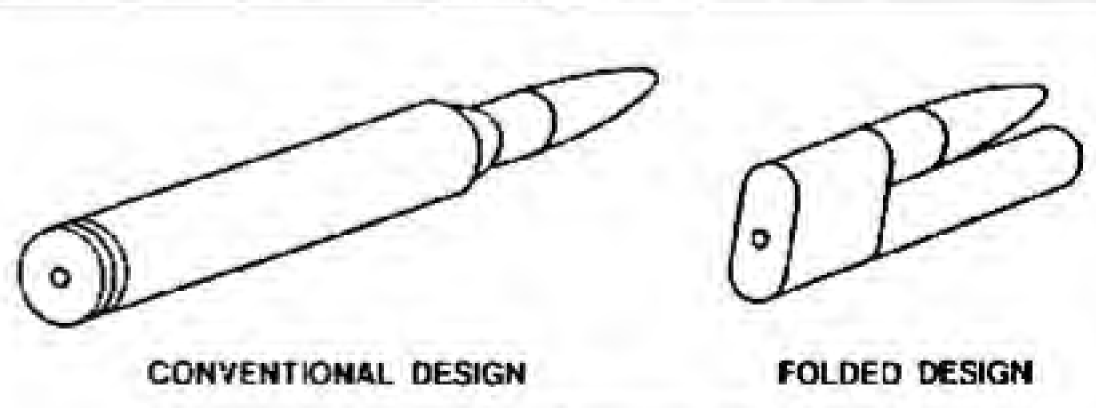
The ammunition concept reveals that one simple expedient was taken—that of folding the propellant charge under the projectile. The same projectile, primer, propellant, and a metallic case are used. It is immediately obvious that cartridge length is reduced significantly using the folded configuration. What is not so obvious is that a substantial reduction in packing volume also is attained.

Packing volume is defined as the minimum-dimension rectangular solid encasing the cartridge. The packing volume of the conventional-type cartridge calculates to 0.323 cubic inch. The effect of folding this cartridge using the same projectile and propellant volume, reduces the cartridge packing volume to 0.228 cubic inch—a 19.4 percent decrease.

This is the dramatic space-saving result of folded ammunition. In addition to this significant benefit, there are other advantages as indicated below.

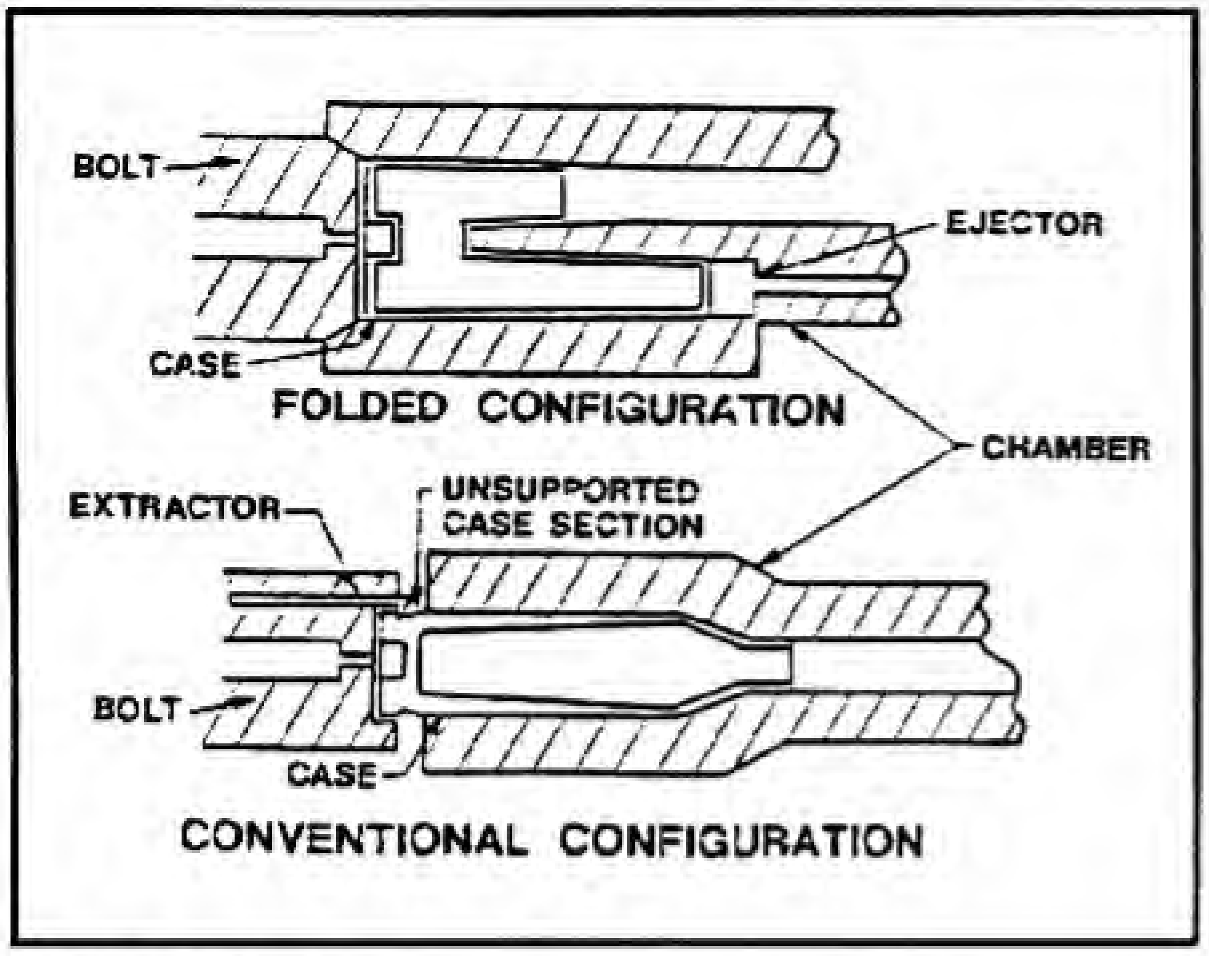
The shorter ammunition length shortens the weapon bolt stroke required to feed the ammunition and extract the case after firing. This feature enables a shortening of weapon length in the chamber/breech location.

Another significant difference between the conventional system approach and the new folded system approach is in the means of case extraction. The

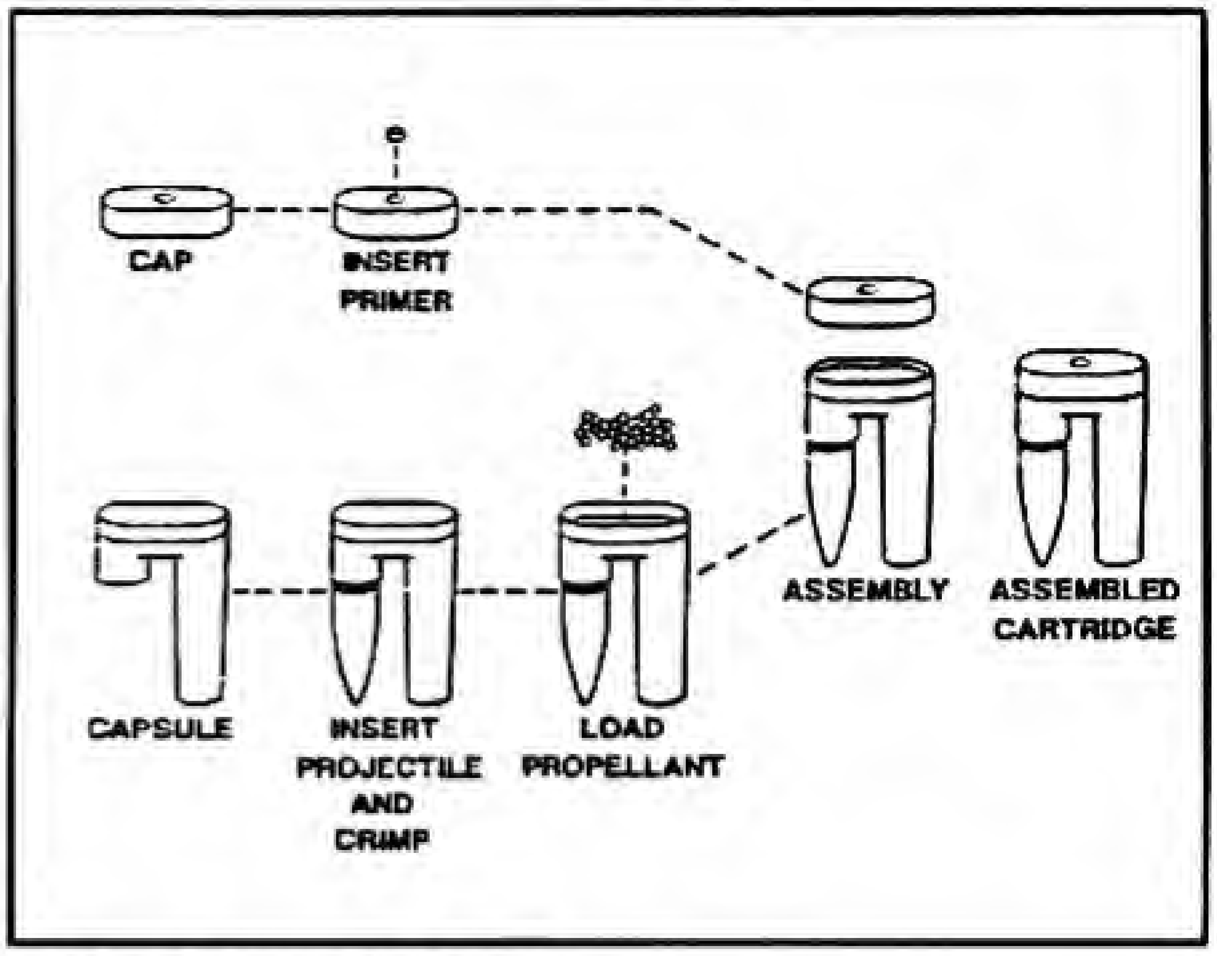


	VOLUME REDUCTION %	LENGTH REDUCTION %	WEIGHT REDUCTION %
5.56 MM M193	38	44	25

Space and Weight Savings with Design



Design Analysis



Load and Assembly Process

use of a pusher-type extractor in the folded configuration should eliminate or minimize extractor breakage which occurs with conventional systems. This is based on significantly greater contact area of the pusher rod on the folded case compared with the small contact area of the conventional extractor claw on the case rim.

With conventional design, the case head is only partially supported in order to provide access for the extractor claw which is associated with the weapon's bolt. Thus the conventional case head must be relatively massive to withstand the pressure developed by the burning propellant.

Since the folded ammunition cartridge case is not extracted from the rear but is pushed out from the front of the propellant capsule, it can be totally supported by the weapon chamber and bolt. This permits design of a substantially thinner walled case significantly lighter in weight than that employed in conventionally designed cartridge cases.

In addition to the above advantages, the folded ammunition/weapon system can be considered safer than conventional systems because complete enclosure of the ammunition by the weapon eliminates the unsupported case head associated with rimmed and rimless cartridge cases.

With respect to safety in production, it will be less hazardous to produce the folded cartridge than the conventional cartridge. Conventional ammunition normally is primed in the early stage of ammunition loading before propellant filling and bullet seating. With folded ammunition, priming is a separate and remote operation to bullet insertion and propellant loading.

One way of visualizing space savings resulting from the folded geometry is to compare the smallest space into which 20 cartridges would be grouped, such as in a magazine. When comparing the 5.56mm M193 cartridge with folded ammunition using the M193 bullet and the same nominal propellant charge, the packed or magazine volume shrinks from 6.23 cubic inches to 3.84 cubic inches for the folded ammunition—a 38 percent reduction.

Extending this comparison between the conventional and folded design characteristics to include cartridge length and weight reduction in addition to volume. The basis for the 44 percent reduction in cartridge length is obvious. What is not so obvious is the reason for the 25 percent reduction in cartridge weight. The only cartridge element that changes in this comparison is the cartridge case weight.

As mentioned, the folded design system approach enables full weapon support of the cartridge in the firing position. Because of this, a completely new and less severe structural requirement arises for the cartridge case as a subsystem element in this weapon/ammunition system.

In the conventional system, the case head must be capable of supporting chamber pressure in that section surrounding the primer and in the vicinity of the extractor groove. This must be done, ordinarily, to accommodate the extractor claw located between the weapon chamber supporting the case and the bolt face of the weapon.

Since the case is fully supported in the folded design, a thin-wall case structure can be maintained in all sections of the case. Only the primer requires a small buttressed zone to maintain mechanical integrity. This reduction in case-head material, between conventional and folded design, results in a reduction of approximately 40 percent in case weight, reducing cartridge weight by 25 percent.

The advantages of folded ammunition and the system improvements that could accrue from its use are outlined below:

Ammunition. Reduced weight, length, and bulk.

Weapon. Reduced bolt stroke, gun length, and gun bulk, and an increase in rate of fire.

System. Efficient packing, improved logistics, improvement in space utilization, and broad application.

In connection with the shortened bolt stroke, at least two benefits stand out: rate of fire can be extended more easily into the higher ranges if that is desired, and, for a given rate of fire, the shortened bolt stroke should enable weapon designers to reduce acceleration of the bolt and associated parts with a resultant benefit to parts life.

From the systems viewpoint and aside from the very significant logistic aspects, improvement in space utilization is of particular importance. This is true not only for efficient ammunition-oriented space containment but also for weapon intrusion into otherwise cramped quarters. Shortened ram stroke requirements play a significant role here. The advantages in system applications to aircraft where volume and/or weight savings can be critical, cannot be overlooked.

Based upon a potential for system improvement beyond that attainable with conventional ammunition/weapon design, a preliminary study was conducted by Frankfort Arsenal to determine the feasibility of folded ammunition.

Design Analysis: An experimental folded test weapon chamber and ammunition cartridge case were designed using the finite element stress analysis technique which took into account chamber and case deflections at peak pressure for satisfactory case performance. The analysis was made using a cartridge configuration designed around an experimental 5.56mm projectile.

There is a significant difference in the weapon support given to the cartridge case in the folded configuration as opposed to the conventional type. The differences in case support mentioned earlier and the reduction in case weight by using a thin-wall design are readily apparent.

Ballistic Study: An interior ballistic study was made to select a propellant for the experimental folded cartridge that would yield velocity and pressure levels comparable to those obtainable in conventional cartridge design. Comparing the interior ballistics of both conventional and folded designs using the same bullet, propellant, and primer. Performance levels are statistically similar. The pressure-time records shown are average curves which are representative of data obtained with the two ammunition designs. The conclusion can be drawn that the folded design does not appear to introduce any negative effects on ignition or propellant combustion.

Case Fabrication/Cartridge Assembly: The folded cartridge case is presently a two-piece assembly consisting of a case body that retains the bullet and propellant; the cap serves to seal the end of the cartridge case, and it holds the primer. Although an impact-extrusion process was used in this experiment to fabricate both of the case components, other techniques could be devised to fabricate these components if it would be economically advisable.

Automatic Firing Fixtures: The construction of suitable hardware to feed, fire, and eject the new folded ammunition shape was essential in this feasibility study. Accordingly, suitable mechanisms were designed, constructed, and tested.

At the completion of a firing cycle, the bolt is closed. The next cartridge to be fired is in the chamber awaiting the fall of the firing pin on the primer for the next shot.

When the cartridge is fired, the bolt is driven back by the propellant gas. As the bolt continues rearward, it permits the next cartridge to enter from the magazine. This cartridge pushes the fired case from the bolt face into the ejection port as it moves into position for chambering.

The return stroke of the bolt completes the ejection of the fired case and chambers the next cartridge, completing the cycle. The bolt is again in the closed position ready for the next shot.

In summary, the principle of the folded ammunition/weapon system has been demonstrated by automatic test firing of experimental prototype ammunition in automatic firing fixtures. Pertinent preliminary technology has been established in areas that are essential to the success of this new design approach.

These include: (1) The capability to match ballistic performance of conventional ammunition; (2) the successful utilization of a two-piece case; (3) the adaptability to state-of-the-art machinery for fabrication of this ammunition, and (4) the potential for development of systems using this principle since it has been shown that the folded-shape ammunition could be automatically fed, fired, and ejected with no indications that this would present a stumbling block in the development of systems using this principle.

Thus far, the technical and functional advances that are made possible with the folded ammunition/weapon system have been developed. However, what impact would this have on the ammunition-production base? Folded cartridges are shorter, lighter, and less bulky than equivalent conventional cartridges. These attributes are highly cost effective when considering large-scale production.

Based upon the experience gained in this initial experimental program and as the result of projections since then, it appears that the folded cartridge case can be produced conventionally using various materials. Because of system attributes (thin case wall, completely supported case in battery, and improved case-ejection technique) less stringent case design requirements should simplify manufacturing.

However, it is not intended that the improvements available in folded ammunition be applied to existing systems, as this would require retrofitting of weapons and retooling of production lines including process development to manufacture the ammunition.

In this respect, a substantial investment has been made in the Army's program for a modernized production base (SCAMP). This is now emerging in the manufacture of 5.56mm ammunition. If, for instance, the manufacture of 5.56mm folded ammunition was imposed on the SCAMP production line, major modifications would be required in the case-forming stations with lesser changes to the primer insert, load/assemble, and packaging operations.

Process and tooling changes could be encountered in applying any new ammunition design to the existing SCAMP production line if it entailed a new material, significant change in shape and, in some instances, a change in the ammunition calibre.

In the broader scope, the application of folded ammunition is a matter of filling a need which would be the basis for the development of a new system not restricted to calibre and use (ground-to-ground, ground-to-air, air-to-ground, and air-to-air). At that time, then, specific manufacturing and logistic implications would be balanced against the cost effectiveness of the new system.

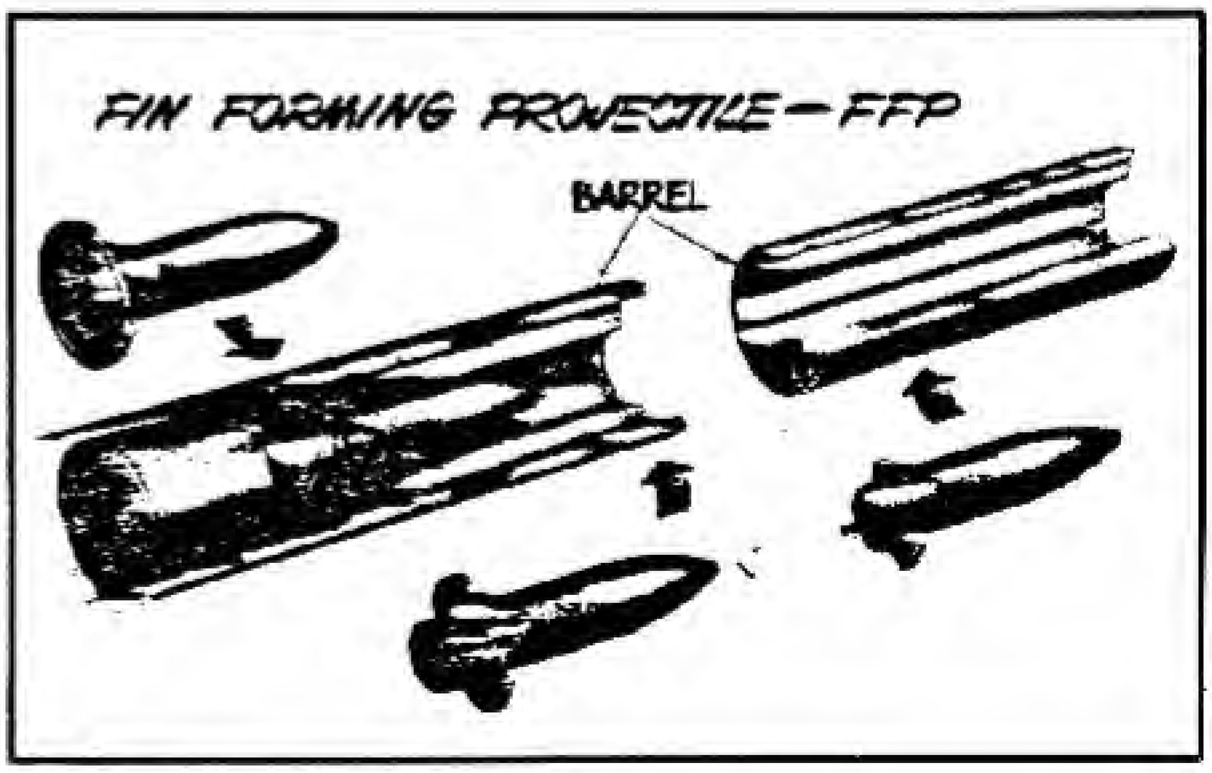
Studies are continuing to examine parameters uniquely associated with this new ammunition configuration both to extend our present technical knowledge and to define any problem areas that might be critical to its successful application.

Some of the parameters requiring better definition are the heat-flow patterns that will develop during automatic fire in a weapon chamber having the folded configuration and the practicability of a two-piece cartridge case as its use is extended beyond the scope of the initial feasibility study.

In summary, the feasibility of a new ammunition/weapon system design has been demonstrated using an experimental 5.56mm system as the test vehicle. With the folded design, significant system gains are possible (vastly improved space utilization, greater ease in accommodating high-performance projectiles by significant reduction in cartridge length, reduction in system weight, and cost-effective logistic deployment by virtue of the above) beyond those attainable using the conventional ammunition approach. All tests and experimentation was suspended due to lack of military interest.

Fin Forming Technique

In February of 1968, an original concept invention disclosure was made by an Aeronutronic employee, Mr. J. F. McCarty, on a technique for forming fins on a projectile as it is propelled through the barrel of a gun. In June of 1968, the Aeronutronic Division of Philco-Ford Corporation sponsored a preliminary evaluation program to build a fin forming barrel and perform some initial evaluation tests. Fifteen rounds were fired by the end of 1968 or early 1969. From January to March of 1969 the company funded program was continued in order to conduct barrel and projectile design studies, and in the fall of 1969 an informal, unsolicited proposal for a feasibility eva-



Fin Form Technique - Concept

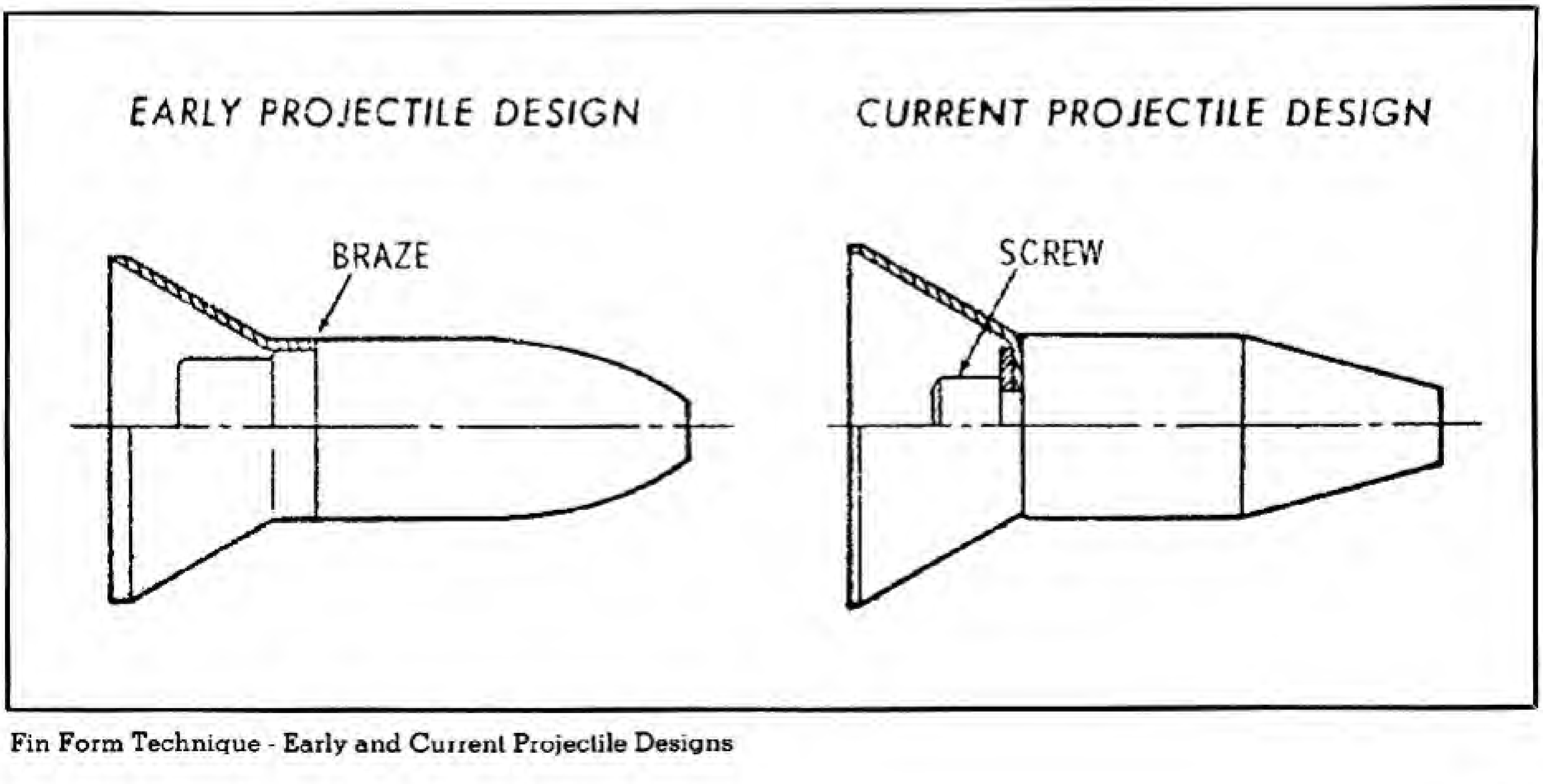
luation program was prepared and presented to the U.S. Army. A year later, in November 1970, a formal proposal was submitted to the U.S. Army Weapons Command which resulted, in June of 1971, in a contract award for the program. The objective of this program was to evaluate the feasibility of the fin forming technique for launching a 30mm fin formed projectile with a weight of 3500 grains at a muzzle velocity of 3000 feet per second.

The fin forming concept was evolved principally as a high efficiency means for launching a fin stabilized projectile. Fin stabilized projectiles have inherent performance advantages over spin stabilized projectiles for shaped charge, multiple flechette, and rocket assisted ammunition applications. The fin forming concept was designed to provide increased projectile base area while the projectile is in the gun barrel and to provide a fin stability system for the projectile after it exits the barrel.

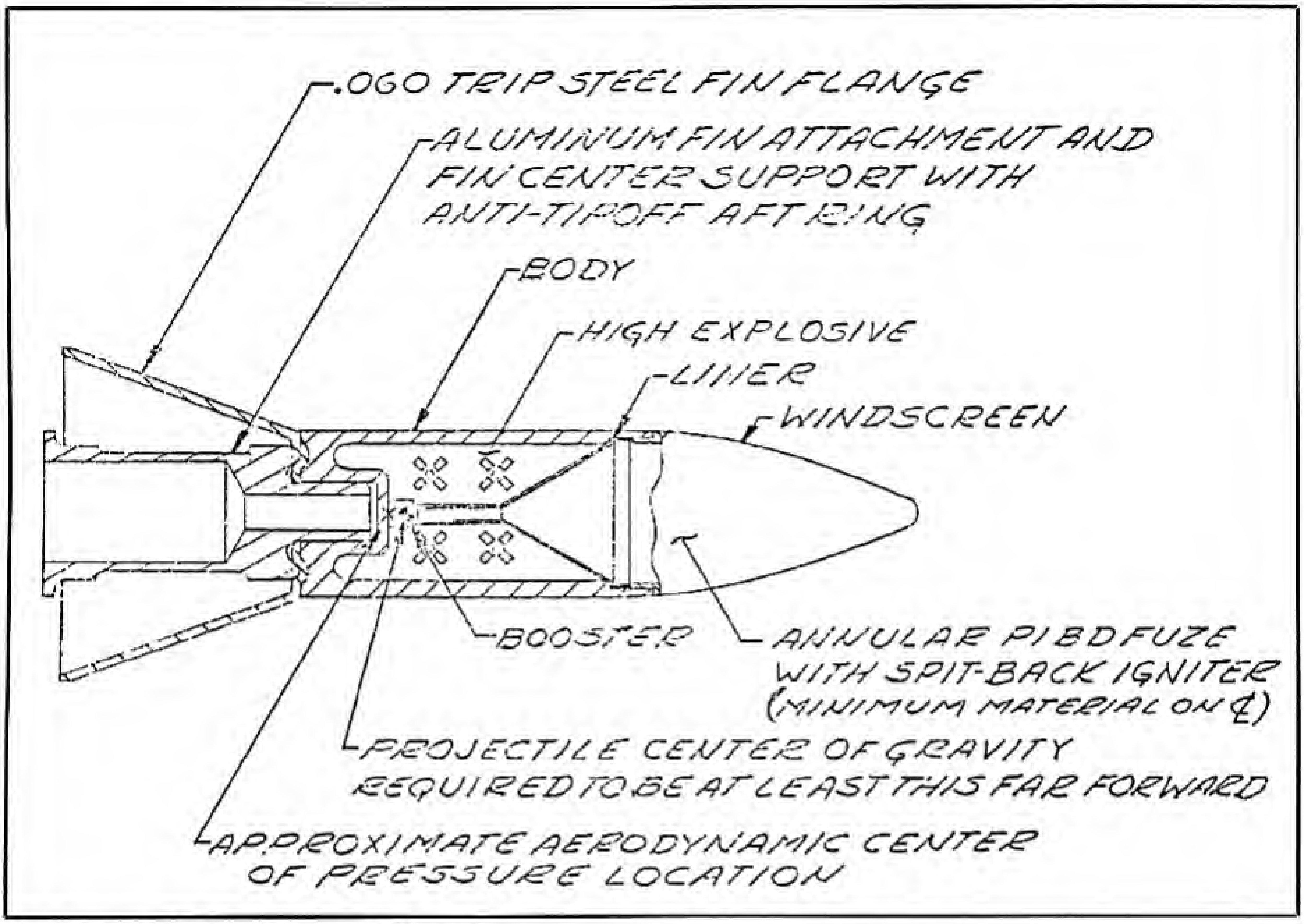
The conventional spin stabilized projectile is poorly suited to the needs of shaped charge (HEAT) penetrators, multiple flechette (MF) packages, subcalibre rod penetrators, and rocket assisted projectiles (RAP). Aside from being expensive to produce, spin-compensated shaped charges are less than 50 percent effective at spin rates needed for stabilization at 3000 ft/sec. On the other hand, if a slow spin (20 to 50 rps) is used together with fins for stability, the warhead would be essentially at 100 percent efficiency. The spin necessary for stability of MF canister introduces centripetal forces which cause 40 to 60 mils dispersion of the flechettes. Subcalibre rod penetrators typically want to have fineness ratios of 10 to 20, thus requiring excessively high spin rates and/or fins for stability. Finally, launch velocity of RAP ammunition is currently limited because of spin rate requirement and to setback loads. The spin requirement presents the most severe restraint.

The fin forming concept employs a conical flange on the projectile which increases the effective base area of the projectile while the projectile is in the gun barrel. The fin flange is progressively formed after firing: first into a large base area cloverleaf shape and then into the final fin launch shape. The flange itself forms the barrel obturator for the projectile as it travels down the barrel. In general, the forming operation is accomplished by means of a series of simple bendings or foldings. Swagging, extruding, or other such operations characterized by large plastic deformation of the metallic flange are avoided.

Although the most significant advantages of the fin forming concept accrue to shaped charge, multiple flechette, and rocket assisted ammunition, the concept also allows rod or single flechette-type kinetic penetrators to be fired without the use of sabots. Additional benefits of the concept are the combination of a better ballistic efficiency and a lower breech pressure for a given muzzle velocity. High projectile muzzle velocities can be achieved at relatively low chamber pressures.



Fin Form Technique - Early and Current Projectile Designs


.060 TRIP STEEL FIN FLANGE
ALUMINUM FIN ATTACHMENT AND FIN CENTER SUPPORT WITH ANTI-TIPOFF AFT RING
BODY
HIGH EXPLOSIVE
LINER
WINDSCREEN
BOOSTER
ANNULAR PIBD FUZE WITH SPIT-BACK IGNITER (MINIMUM MATERIAL ON ℄)
PROJECTILE CENTER OF GRAVITY REQUIRED TO BE AT LEAST THIS FAR FORWARD
APPROXIMATE AERODYNAMIC CENTER OF PRESSURE LOCATION

Fin Forming Projectile - Generalized Concept

Barrel Design

In the area of barrel design, various concepts for the manufacture of a fin forming barrel was evaluated. A possible typical external and overall barrel configuration concept was extended. A feasibility test of such a barrel configuration and its manufacturing concept was also attempted.

One theory of the success of the fin forming technique is the internal forming configuration of the barrel. Several constraints and tradeoffs were involved in its original design.

The first forming transition (from a conical flange to the cloverleaf flange) is constrained to occur in the length of the projectile in order to provide barrel lands for the initial support of the projectile forebody. After the first forming transition region, the cloverleaf cross section is constant for the majority of the barrel length. Final fin forming is performed near the end of the barrel. An eventual barrel design would probably also have a very slight constant overall twist to neutralize any projectile rotation with a low projectile roll rate. In the firing test fixture designed and built for this program, the final fin forming transition section is followed by 11 inches of gain twist of the final barrel cross section to provide this slow (40 rps) rotational velocity to the projectile.

Many design studies and tradeoffs were peformed during the study. These studies included efforts directed towards minimizing fin flange forming strains and strain application rates, and also towards obtaining a manufacturable test barrel configuration. Computer programs were developed to describe the barrel bore transition geometries for various prescribed constraints.

One of the most readily observed results of these design studies was a change from the initial three finned design concept to a four finned configuration. This change was accompanied by a corresponding reduction in the ratio of the cloverleaf barrel cross section area to the projectile base area, which results in a small reduction to ballistic efficiency. It was determined to be required to utilize the four finned configuration in order to provide a more manufacturable barrel and also to provide confidence in the attainment of adequate fin aerodynamic effectiveness.

Projectile Design

Projectile design studies centered largely on the fin material requirements and attachment techniques. Aerodynamic stability analyses were also performed to determine fin geometry and center of pressure relationships. A mass properties computer program was also developed for a basic test projectile design concept and was used in configuration tradeoff studies to establish the final test design. The test projectile design was established so as to be quite easily modified during the test program and these capabilities were utilized.

In the area of projectile fin design concepts, the information desired relates to determining achievable fin structural capabilities at minimum weight. The fins must be lightweight enough that an aerodynamically stable projectile configuration can be designed without any excessive nose ballast weight requirements to compensate for fin weight. A high fin structural strength, of course, is required for good internal ballistic performance.

The projectile length is an important barrel design parameter, since it establishes the maximum length of the initial forming section wherein the flange is transformed into the cloverleaf shape. Furthermore, the strain rates (bending) induced in the flange during the forming operation are a function of the length of the initial transition section and hence the projectile length.

A projectile mass properties computer program was developed so that the effect of changes in projectile configuration on aerodynamic stability could be studied parametrically. The program computes the length, weight, center of gravity (CG) location and inertias (both roll and pitch) of the projectile for the condition of a fixed overall weight constraint. The computer program provides the tool necessary for parametrically studying the net effect on projectile mass properties as a result of variations in flange thickness, flange angle, ogive configuration (cone angle and meplat diameter), component materials (densities), etc.

Fin Forming Firing Fixture

The Fin Forming Test Fixture is designed to fire a 30mm skirted round of ammunition utilizing bagged propellant in a single shot mode of fire. The concept employs a conical flange on the projectile to increase the effective base area of the projectile. The internal contour of the barrel forms the conical flange into a set of fins which serve to stabilize the projectile after it exits the muzzle. In general, the forming operation is accomplished by means of a series of simple bendings or foldings. Swagging, extruding or other such operations characterized by large plastic deformation of the metallic flange are avoided.

Although the most significant advantages accrue to shaped charge, multiple flechette and rocket assisted ammunition, the concept also allows rod or single flechette-type kinetic penetrators to be fired without the use of sabots.

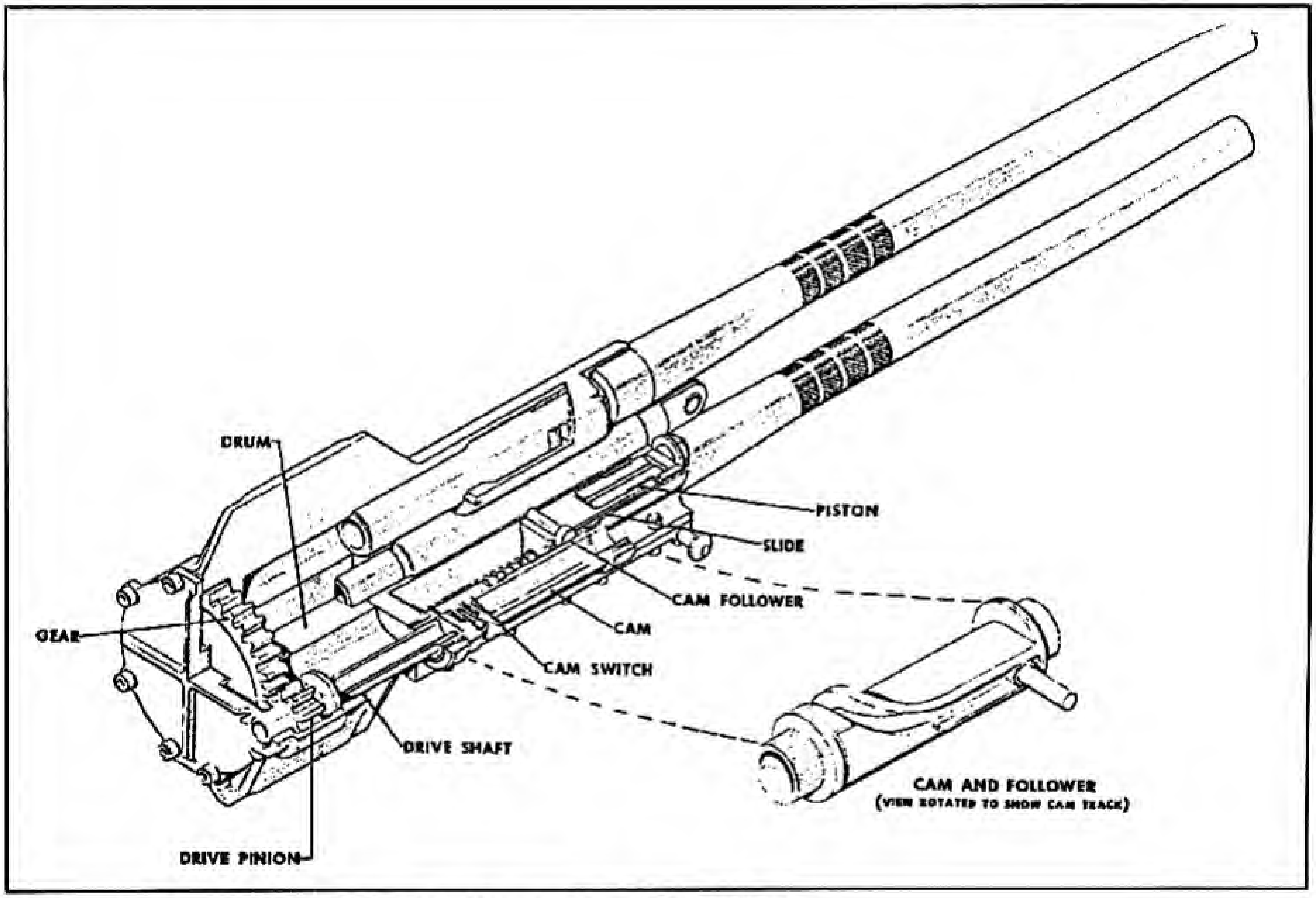
Muzzle energies achieved in some of the firing tests exceeded the muzzle energy for the specific 3000 ft/sec with a 3500 grain projectile feasibility study objective. The highest muzzle energy that was achieved was 81,800 ft-lb from a 4480 grain projectile at 2870 ft/sec. The highest velocity achieved was 2930 ft/sec and was with a 4090 grain projectile.

Testing was performed for the purpose of evaluating the fin forming concept against a desired performance level of 3000 ft/sec with a 3500 grain projectile. This desired performance level can be equated to a desired projectile muzzle energy of 69,932 ft-lb which was actually exceeded on eight of the firing tests according to test measurements.

All tests were suspended due to lack of military interest.

Chapter 69

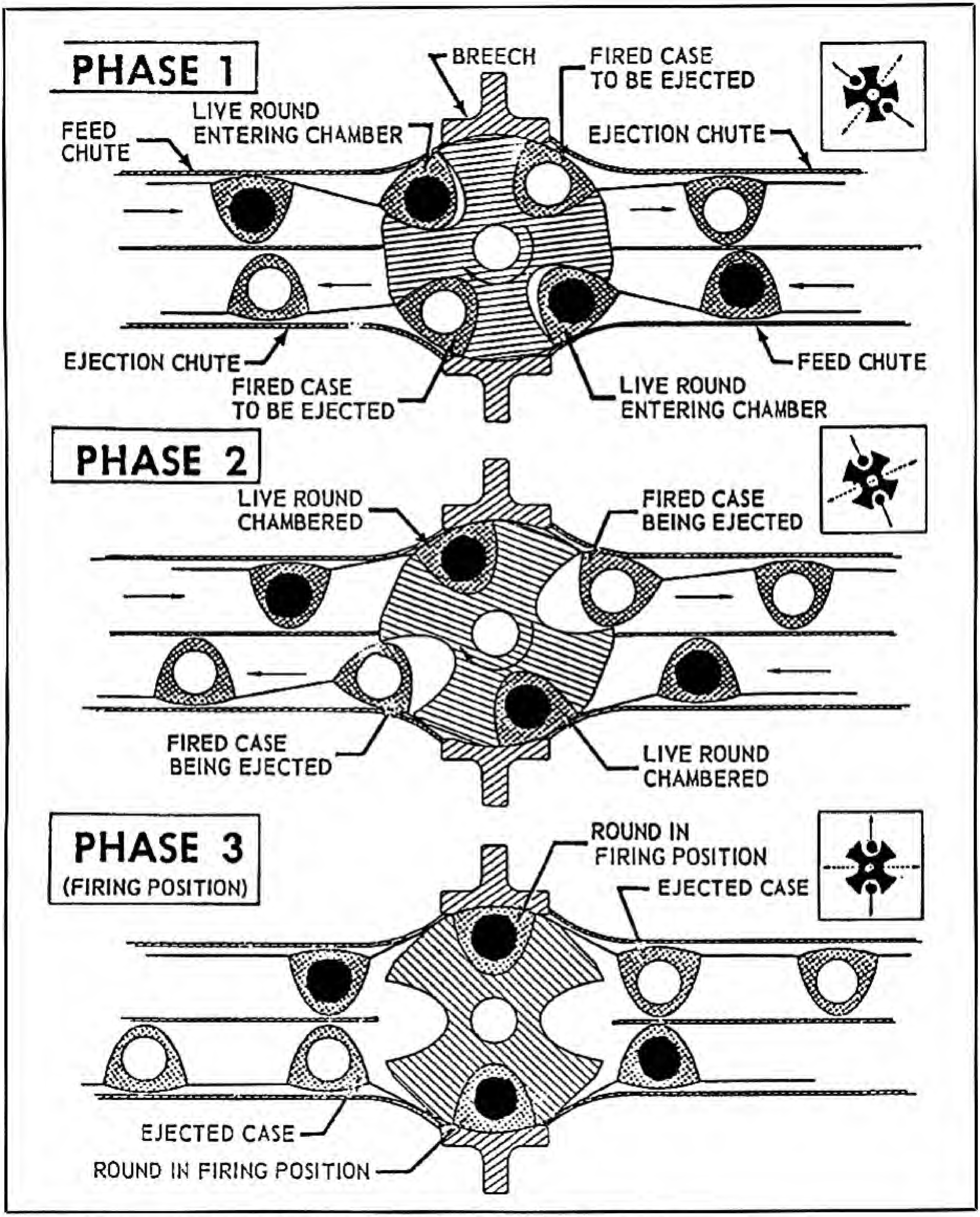
THE OPEN-CHAMBER CONCEPT AND ITS APPLICATION TO THE 30mm T154 GUN DESIGN


DRUM
PISTON
SLIDE
CAM FOLLOWER
GEAR
CAM
CAM SWITCH
DRIVE SHAFT
CAM AND FOLLOWER
(VIEW ROTATED TO SHOW CAM TRACK)
DRIVE PINION

Gas-Operated Cam-and-Gear Driven Open-Chamber Gun - Cutaway View

The Open-Chamber Principle. The open-chamber is radically different in principle from the closed chamber used in conventional guns. Although the closed firing chamber provides a practical method for restraining the cartridge case during the firing period it is subject to objection because of the time required for the reciprocating action necessary to move the cartridge a distance equal to its length during the loading and unloading operations. Also, of course, the reciprocating mechanism is complicated, costly, and prone to malfunction. The open-chamber system eliminates the longitudinal, reciprocating motion by feeding the ammunition into the chamber from the side.

Several configurations are possible with this new principle. In one simple configuration the chamber is


PHASE 1
BREECH
FIRED CASE TO BE EJECTED
LIVE ROUND ENTERING CHAMBER
FEED CHUTE
EJECTION CHUTE
EJECTION CHUTE
FEED CHUTE
FIRED CASE TO BE EJECTED
LIVE ROUND ENTERING CHAMBER
PHASE 2
LIVE ROUND CHAMBERED
FIRED CASE BEING EJECTED
FIRED CASE BEING EJECTED
LIVE ROUND CHAMBERED
PHASE 3
(FIRING POSITION)
ROUND IN FIRING POSITION
EJECTED CASE
EJECTED CASE
ROUND IN FIRING POSITION

Sequence of Ammunition Feeding, Ejecting, and Firing in T154 Open Chamber Gun formed of two components, one stationary and one rotating on an axis parallel to the gun barrel.

Non-Circular Open-Chamber Cartridge. Although the advantages of the open-chamber principle have been known for many years, it appears that every attempt to build a workable gun has resulted in failure because the circular cartridge case that was invariably used ruptured when fired in a longitudinally split chamber. Since all experimental evidence indicated that the circular cartridge case was incompatible with the open-chamber principle, Hughes Tool Company Aircraft Division decided to investigate the possibility of using one of non-circular cross section, which can be indexed in a fixed position in this chamber of unconventional design. If such a case were suitably reinforced in the critical area, and if it were supported on all sides, a considerable amount of breech deflection could be tolerated without causing the case to rupture. Controlled reinforcement would be impractical in a circular case because there is no simple way of indexing it in a fixed position without adding exterior protrusions and bringing about other complications. The particular cross section chosen also has the advantage that it naturally provides thicker walls at exactly the places they are needed, since, inherently, there is excess material at these points if a more or less round cavity is used in the case.

Telescoped Round Feature. The telescoped round feature was combined with the non-circular, open-chamber shape. The telescoped round had been developed during earlier studies made by Hughes Tool Company Aircraft Division for improving circular ammunition for use in advanced automatic weapons. The telescoping feature makes possible many advantages that are not inherent in conventional ammunition. The cartridge case used in the telescoped round fully encloses the projectile and is so designed that the projectile is surrounded by the propellant. With such a configuration it is possible to obtain two advantages: (1) To greatly reduce the overall length of the round, and; (2) To achieve any cartridge case cross section desired all the way to the forward end of the projectile. The telescoped round concept allows the choice of a configuration that can be fed into the gun from any one chosen direction—front, rear, or side. The possibilities that this offers in gun design are too many to outline here. The advantages include a simpler mechanism, a shorter gun, higher rate of fire, and elimination of cook-off. Considering the many advantages afforded by the telescoping feature, it was logical to combine this principle with the non-circular shape.

In comparing the 30mm open-chamber round with the 30mm reversed-taper round, there are several differences in location of the propellant that are worthy of note:

(a) The 3900 grain T306E10 projectile used in the open-chamber round is considerably shorter than the 4900 grain T239E15 projectile used in the reversed-taper telescoped round (3.53 inches vs. 4.45 inches).

Interposed are two elements that can function as very powerful brake shoes depending on the friction of the material combination adopted. The characteristic expansion of the cartridges as the high internal pressure of firing acts through the large areas bearing on the breech can be made to arrest and defer rotation. If there were applied to the drum a continuous driving torque, such as could be provided by a fluid motor, the intermittent deceleration of the drum, followed by its release for indexing, would thus be controlled by the ammunition itself.

The T154 guns were used in several different versions, by several different companies, to develop the so-called "tround" of ammunition.

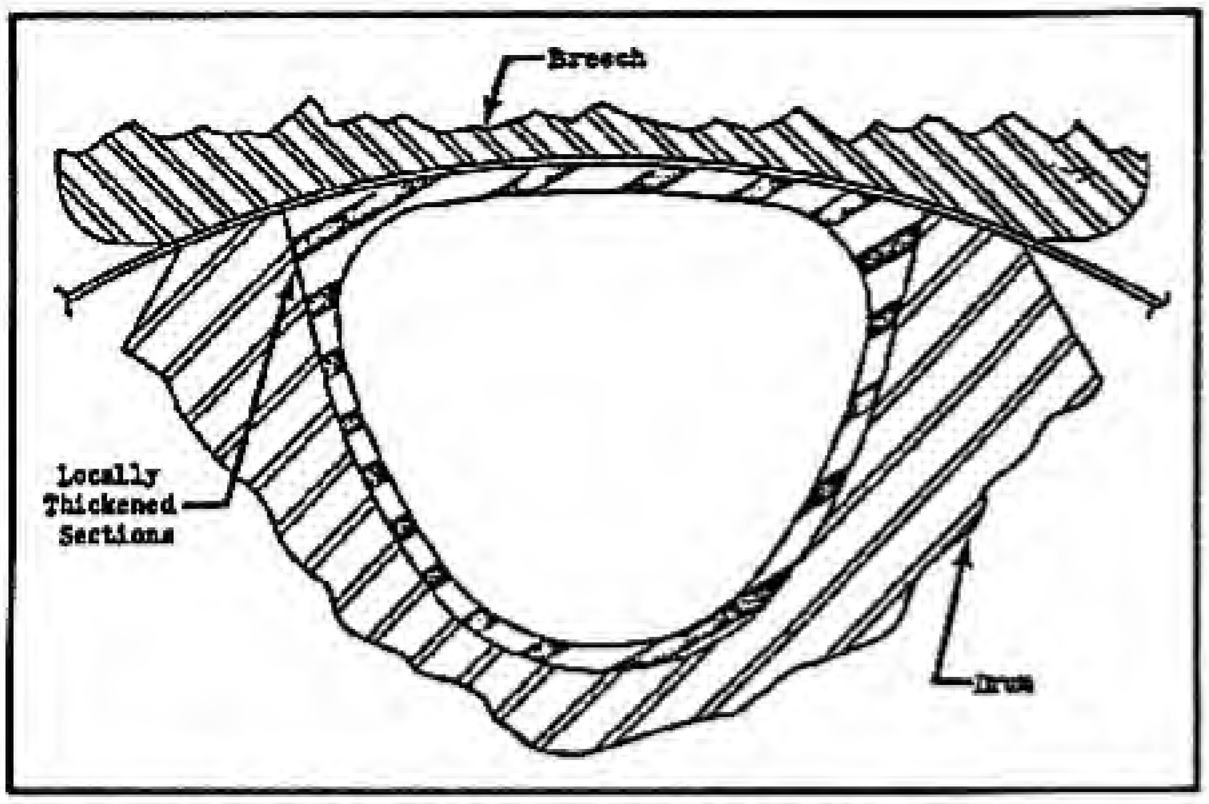
The following are just a few of the companies to attempt to use the caseless ammunition with varying results.

SECTION 1. HUGHES TOOL COMPANY

History

The T154 was developed by Hughes Tool Company. It was monitored by the U.S. Army, and was, in fact, part of a U.S. Air Force T154 program for the development of a Tail-Turret weapon. The work began in September 1954 and ceased with the submitting of the final report on May 31, 1956. An earlier contract from February 1953 to November 1954 covered the preliminary work on the weapon.

The T154 weapon had reached a stage of development to be no more than a single shot firing fixture. Much of the work done on this experimental concept dealt with the unusual designed telescoped ammunition neccessary for the utilization of the open chamber principle.



Thicker Case Walls at Chamber Discontinuities

Description and Purpose

The Hughes four shot test fixture demonstrated a 0.034 second cycle, which was equivalent to a cyclic rate of 3530 rounds per minute. A cycle analysis showed that, with proper timing, this test fixture could achieve a rate of fire of 4000 rounds per minute. No unusual problems were encountered in rotating the drum under prevailing residual pressure.

A Hughes weight analysis showed that the finalized, 4900 grain projectile, automatic gun should weigh no more than 195 pounds, including drive and feed arrangement. The validity of this estimate was indicated by the fact that the weight is an extrapolation from existing hardware, as far as the important components are concerned, and not a theoretical computation.

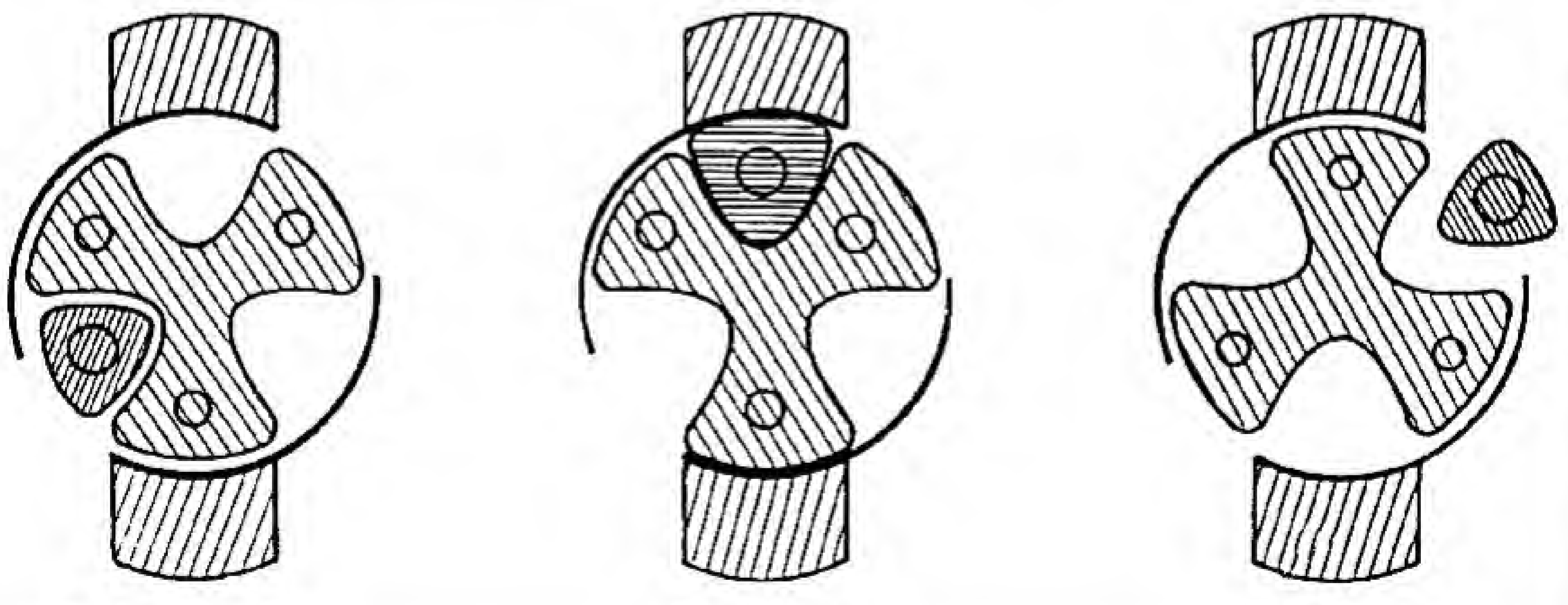
The existing breech and drum of the four-band test fixture, though designed a bit on the conservative side, have size configuration close to the finalized parts so that extrapolation is safe. The 20 pound barrel weight is an extrapolation from the 18 pound barrel used on the T138 gun. Since the breech, drum, and barrels represent 80 percent of the total weight, the prediction should be accurate.

While a 150 pound weapon was desired for the final T154, the fact that the open-chamber approach results in more than 150 pounds was not considered significant by Hughes since each round was about 3/10 of a pound lighter than a conventional round and, the effect of this upon total system weight was that for a 1200 round ammunition complement, the T154 open-chamber gun system would be several hundred pounds lighter.

The purpose of ammunition development work was to prove the principles of open-chamber ammunition; it was not to develop a round of the lowest cost, of the lowest weight, or of functional perfection under environmental extremes or automatic firing conditions. However, a number of elements to the ammunition design have been conceived incidentally during the program, a few of which are listed below:

1. *Weight-Reduction Refinements*

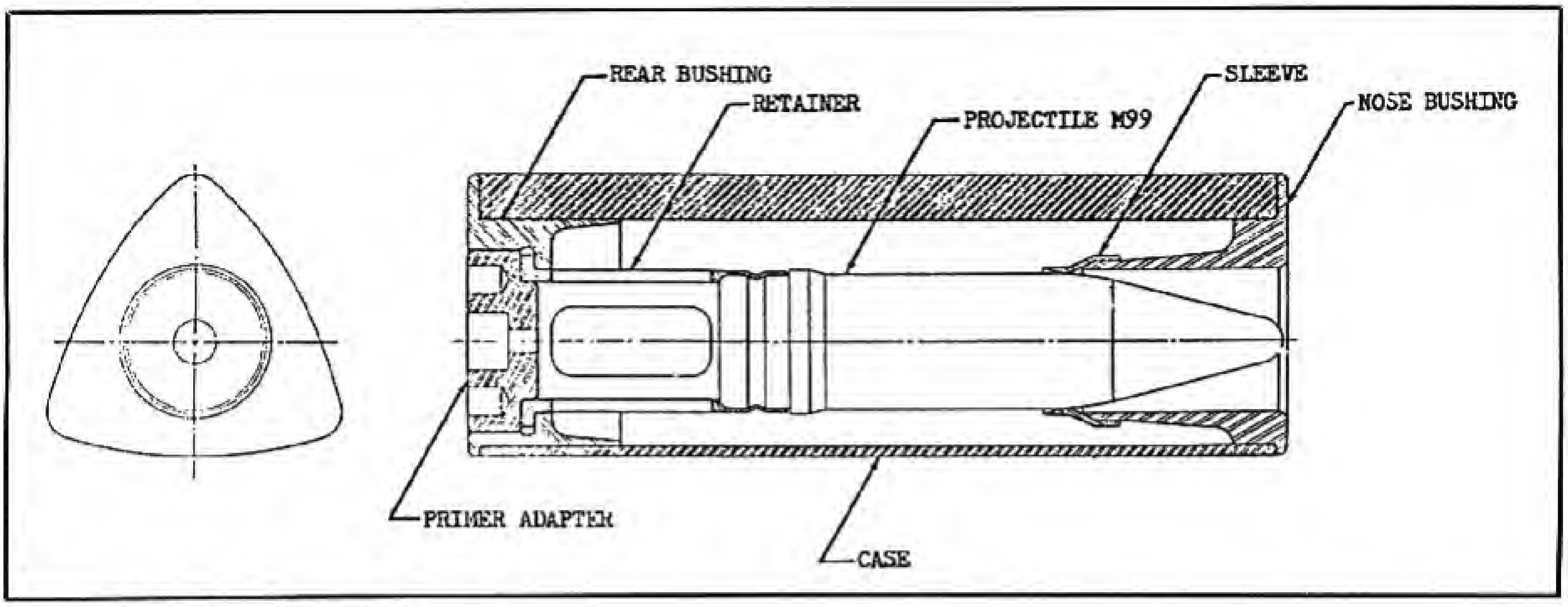
a. Use of aluminum for the guide tube. Anodized aluminum has worked very well in the nose bushing,


Feeding From Side

Firing At Top

Side Ejection

Open Chamber Guns



Hughes T154 20mm Cartridge Design I

where it is subjected to very intense gas wash. It is believed that anodizing likewise will make possible the substitution of minimum for steel for the guide tube.

b. Decrease in thickness of parts. No attempt has been made to determine minimum section thicknesses. This applies, among other things, to the elastomer wall.

c. Use of plastic materials. It is believed that ultimately each part in the round can be made of plastic material of one type or another. ("Plastic materials" as used here include thermoplastic, thermosetting, elastomer, non-elastomer and rubber materials and any other types or categories in this same general family.) The predominant loading on these parts is compression, for which plastics are ideally suited. For certain components a specific requirement is an ability to undergo sizable deflections without yielding. Plastic materials that fulfill this requirement can readily be selected.

Test Results

Development tests demonstrated that the open-chamber concept was considered feasible but unproved at this point. The concept has not advanced beyond this experiment stage.

Hughes 30mm Tround Ammunition (Photo courtesy of Woodin Laboratories.)

SECTION II. PACHMAYR

History

The objective of the T154 program was a design study to determine the feasibility of an automatic aircraft gun capable of firing the 30mm "ADEN" projectile at a cyclic rate of 4,000 rounds per minute and at a muzzle velocity of 3,000 feet per second. In addition to these requirements, limitations were placed on weight, ejection and distance from the base of the projectile to the rear of the gun.

The ultimate objective of the T154 program was the development of the smallest turret type weapon possible, that would maintain the highest performance and kill probability.

Pachmayr's work was done under Contract Feasibility Study -30mm, T154, Gun Automatic, completed in November 1954.

This work envisioned development of a complete gun mechanism capable of firing the 30mm "ADEN" projectile.

During the course of the investigation, "unconventional" ammunition use for all designs was considered. The 4.00 inch dimensional limitation from the base of the projectile to the rear of the gun was a determining factor in the design of ammunition for any given T154 gun mechanism.

The Hughes Tool Company was also engaged in an "unconventional" ammunition study for use with the T154 gun mechanism. The ammunition shown in their progress reports was applicable to the Pachmayr Corporation Design "C" gun mechanism. So for the final report, the ammunition for use with the Pachmayr Design "C" gun mechanism was modified in accordance with Hughes Tool Company data.

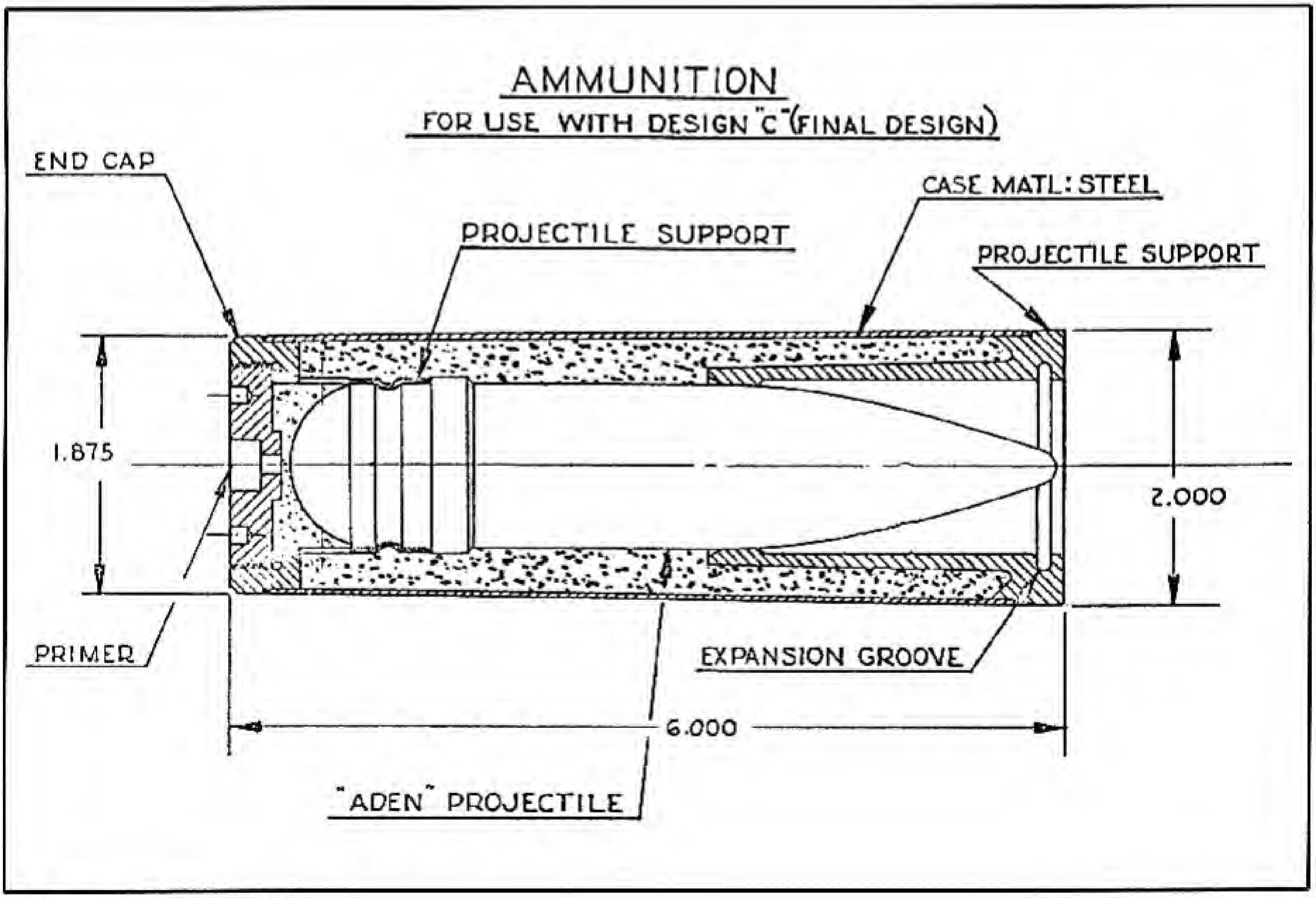
During the report period of July 1954, the Design "C" gun mechanism was submitted to Springfield Armory, Springfield, Mass.

The weapon as submitted was considerably in excess of the desired weight, however, work accomplished to that time indicated the weapon would in other respects meet the requirements of the feasibility study.

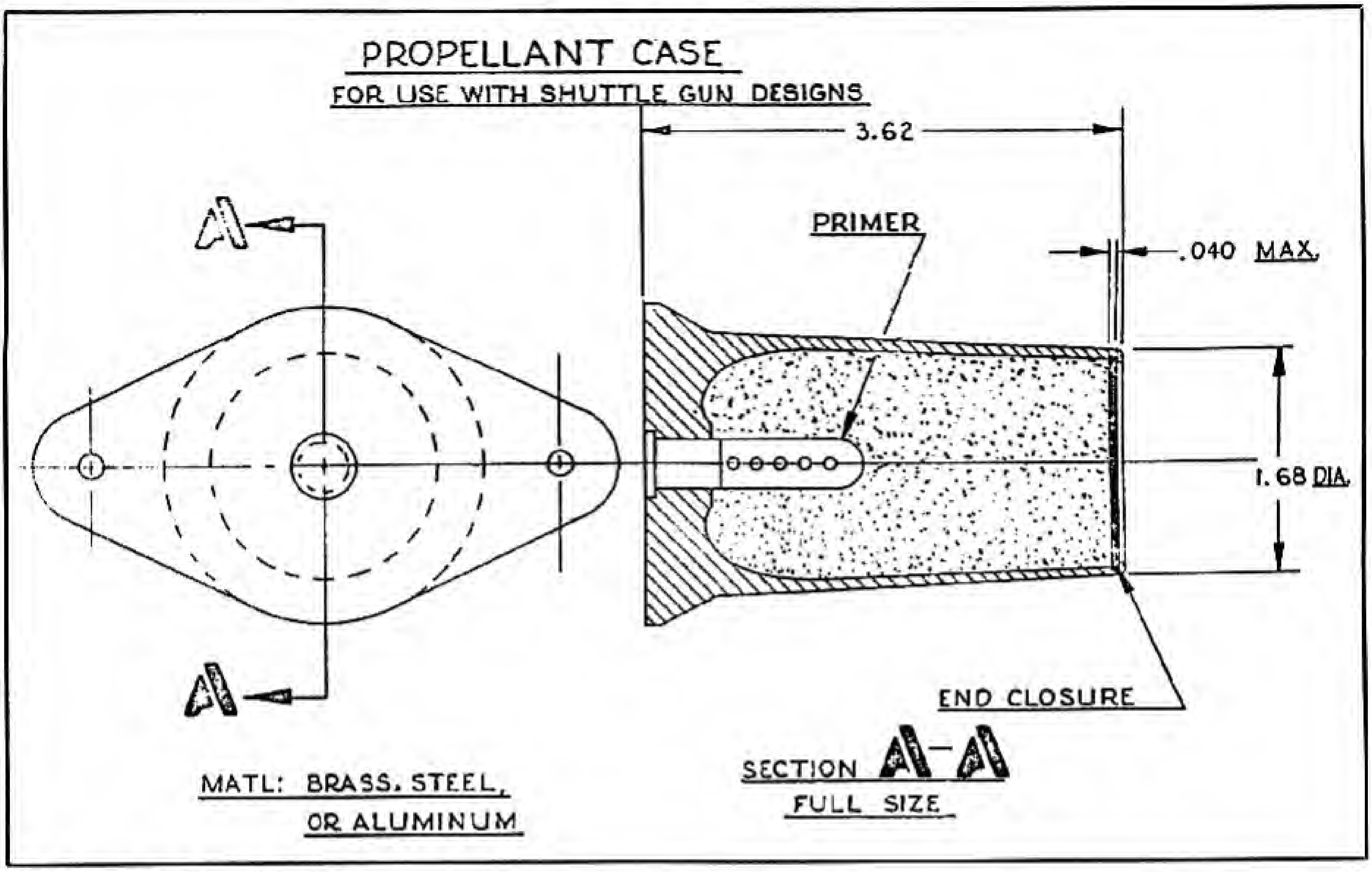
For the balance of the time remaining on the contract, work was done to reduce the weight of this weapon to a reasonable value. To obtain the desired weight reduction, it was necessary to make numerous modifications to the design.

In addition to the weapon submitted for approval, four other gun mechanisms were investigated. These were the Shuttle gun design, the push-pull crank application of the shuttle principal, the reciprocating chamber gun, designated as Design "A" and the externally powered revolver gun, designated as Desgin "B." All of these mechanisms employ the use of unconventional ammunition.

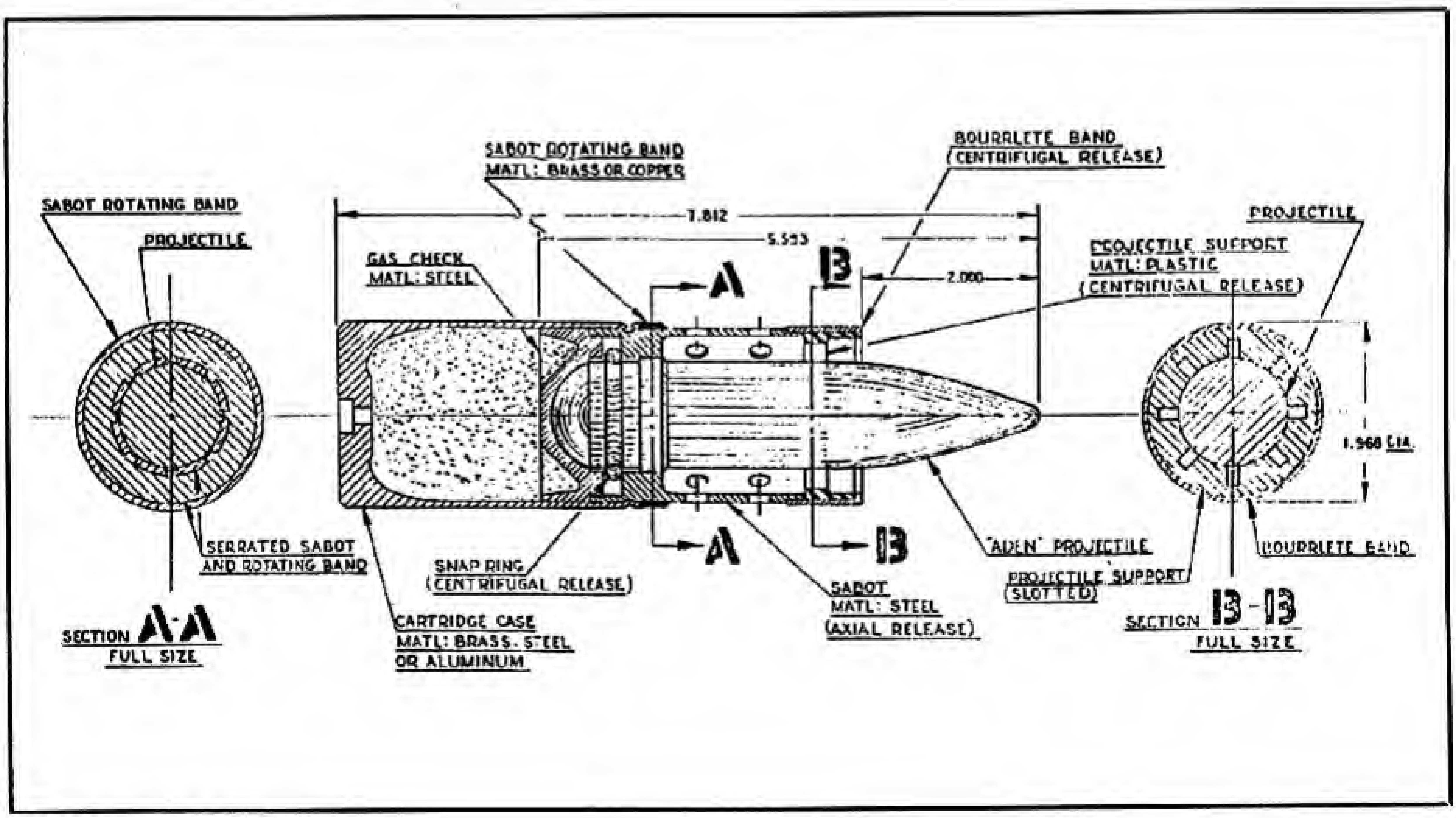
With the exception of the Design "C" gun mechanism, all designs were discarded as unfeasible. Design "C" is a Marquardt type mechanism.



Pachmayr T154 Ammunition


PROPELLANT CASE
FOR USE WITH SHUTTLE GUN DESIGNS
3.62
A
A
PRIMER
.040 MAX.
1.68 DIA.
END CLOSURE
SECTION A-A
FULL SIZE
MATL: BRASS, STEEL,
OR ALUMINUM

T154 Pachmayr Propellant Case


SABOT ROTATING BAND
MATL: BRASS OR COPPER
BOURRLETE BAND
(CENTRIFUGAL RELEASE)
SABOT ROTATING BAND
PROJECTILE
7.812
5.553
GAS CHECK
MATL: STEEL
A
B
2.000
PROJECTILE
PROJECTILE SUPPORT
MATL: PLASTIC
(CENTRIFUGAL RELEASE)
1.968 DIA.
SERRATED SABOT
AND ROTATING BAND
SNAP RING
(CENTRIFUGAL RELEASE)
A
B
"ADEN" PROJECTILE
BOURRLETE BAND
SABOT
MATL: STEEL
(AXIAL RELEASE)
PROJECTILE SUPPORT
(SLOTTED)
SECTION A-A
FULL SIZE
CARTRIDGE CASE
MATL: BRASS, STEEL
OR ALUMINUM
SECTION B-B
FULL SIZE

T154 Discarding Sabot

SECTION III. ARMOUR RESEARCH FOUNDATION

The Armour Research Foundation's (ARF) T154 gun employing combustible case ammunition represented great effort in attempting a departure from conventional ammunition resulted in a broad U.S.A.F. T154 development program.

History

Armour Research Foundation (ARF) performed work on "Feasibility Study of 30mm Automatic Aircraft Gun, T154." On the basis of two of the eleven weapon designs evaluated under that program, ARF was requested to submit a research proposal for the design, development, and testing of a 30mm automatic weapon system utilizing combustible case ammunition. Subsequently, a proposal was submitted and accepted.

Work started in May 1955 on "Development of a 30mm Automatic Gun for Use with Combustible Case Ammunition." A separate contract was negotiated in May 1957 for the further development of the ammunition; "Development of Cartridge, Ball, 30mm, T334." The weapon and ammunition programs were under the technical supervision of Springfield Armory and Frankford Arsenal respectively.

The work performed was divided into four phases:

Phase A - Design Studies. This phase covered the review of previous work on combustible case ammunition and weapons using such ammunition. Next, various weapon arrangements were devised, in an attempt to meet the general requirements of the 30mm Gun, T154, and to exceed the performance of the 30mm Gun, T212, Gatling-type and ammunition design layouts were prepared. Kinematic and dynamic analyses of the weapon arrangements were conducted to predict performance characteristics and recommendations were made for the selection of a weapon design for further development.

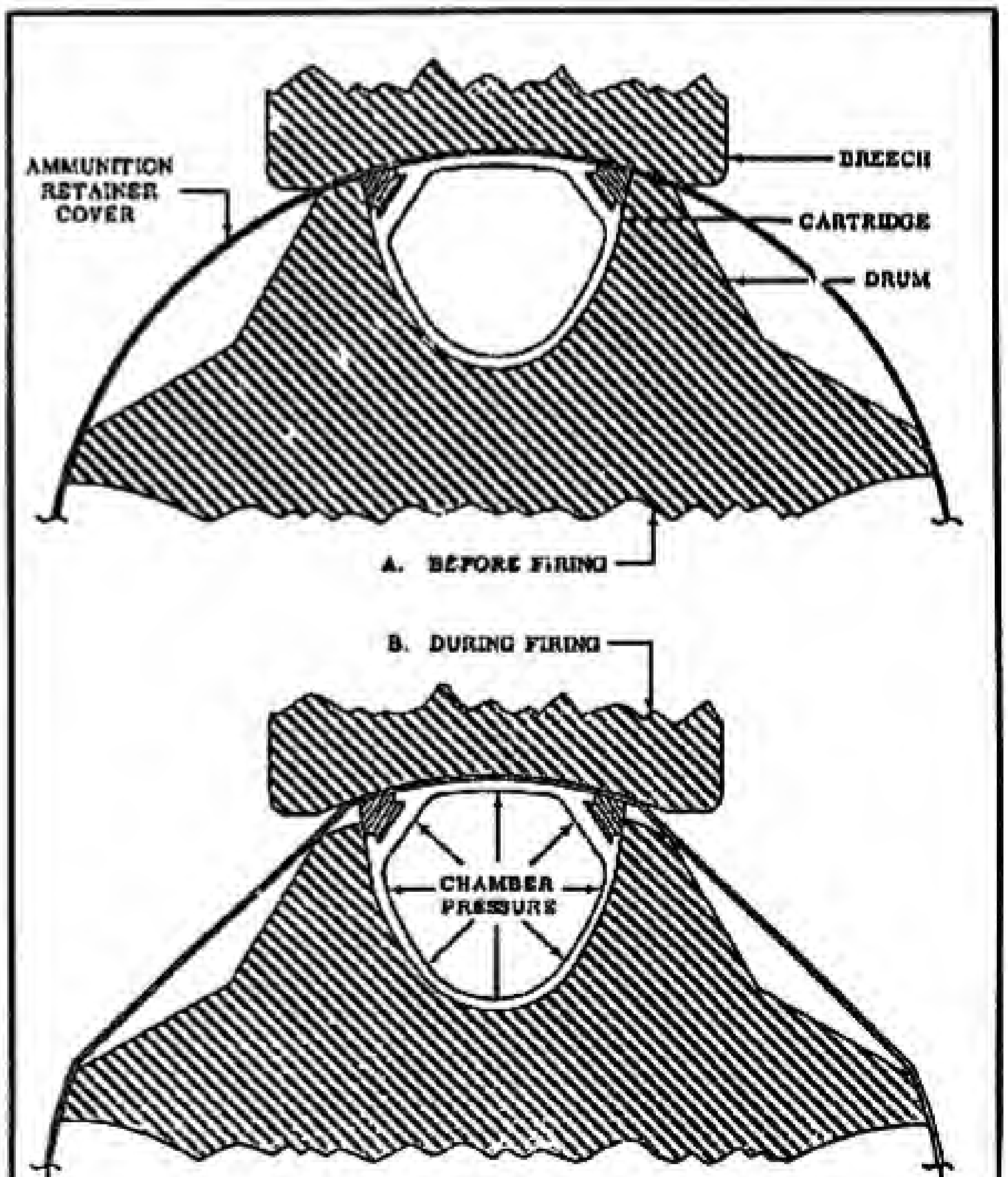
Phase B - Design and Manufacture of Experimental Gun, Model No. 1. The design and manufacture of experimental gun, Model No. 1, was completed, embodying the features of the weapon design selected for future development.

Phase C - Design of a Prototype Weapon. A testing and development program, involving both experimental gun, Model No. 1, and a 30mm single-shot test fixture, was conducted, and combustible case ammunition was manufactured, tested, and developed. The design of an improved gun, designated experimental gun, Model No. 2, was initiated.

Phase D - Design of a Prototype Weapon. The design of experimental gun, Model No. 2, was completed, and a 1/2-scale working model and 1/10-scale solid models of this weapon were manufactured. Experimental gun, Model No. 1A, a modified version of Model No. 1, was fabricated and tested. Development of the ammunition was continued, utilizing experimental gun, Model No. 1 and 1A, and the single-shot test fixture.

The following items were furnished as end items under the gun development contract:

1. Experimental gun, model No. 1A, in operating condition, complete with soft mount,12-round feed chute, and spare parts.
2. Parts required to convert model No. 1A to experimental gun, model No. 1.
3. A 30mm single-shot test fixture, in operating condition, with spare parts.
4. A 1/2-scale operating model of model No. 2.
5. Six 1/10-scale solid models of model No. 2.



The Ammunition Retainer

6. Complete sets of detail and assembly drawings for experimental gun, model No. 1, 1A, and 2, and the single-shot test fixture.
7. A set of drawings of a proposed brake and brake-fixture design.
8. Design layouts of the nine weapon designs evolved during the initial phase of the program.

In addition, 300 rounds of ammunition were manufactured. All work was completed by March 1959.

Test Results

The weapon design and development program, as of January 31, 1959, the termination date of the contract, produced a weapon, designated experimental gun model No. 1A. A summary of the results of the program follows.

Approximately 300 rounds of combustible case ammunition were fired through experimental gun, model No. 1 and 1A. During a nine-round burst, a maximum rate of 4140 rd/min was reached in 174 msec. The requirement was to reach a rate of 4000 rd/min within 200 msec.

Peak chamber pressures were maintained below 50,000 psi, as required, although muzzle velocities averaged 2400 ft/sec during firings in experimental gun model, No. 1 and 1A, below the 3000 ft/sec requirement.

Experimental gun, model No. 1A, weighs approximately 400 lb, double the 200 lb requirement. However, no effort was made to reduce weight of such components as the cams, rotor, gas cylinders, rear bearing plate, and the barrels. Experimental gun, model No. 2, which was carried only into the design stage, has an estimated weight of 250 to 300 lb.

Gun model No. 1A is a free-running automatic weapon.

The weapon design and development program provided the feasibility of a soft-mounted Gatling-type weapon, utilizing reciprocating sleeves as chambers, driven rotationally by an internal gas-drive motor, and using 30mm combustible case ammunition. Many refinements, both in the physical and performance characteristics, remain to be incorporated in the weapon and ammunition. However, the program indicated the feasibility of the basic weapon principles.

SECTION IV. OLIN MATHIESON CHEMICAL CORPORATION

History

A contract was awarded to the Olin Mathieson Chemical Corporation on November 23, 1955.

The object of this T154 contract was to design, develop, fabricate, and test a sufficient number of rounds of Fiberglass wrapped cases, 30mm ammunition, with a self-contained chamber to determine the feasibility of its application to a 30mm T154 type Aircraft Automatic Gun Mechanism.

Prior to this contract, Olin had engaged in several corporation sponsored studies to evaluate the commercial and military possibilities of the applications of Fiberglass. One of the studies included proposals on how best to improve the design of present high cyclic rate automatic weapons, and to solve their inherent "cook-off" problems. It was during this study that the idea was conceived of a 30mm self-contained chamber round consisting of Fiberglass wrapped on an aluminum liner.

As a result of these studies, Olin was awarded the Ordnance Contract "Design Feasibility Study Pertaining to an Aircraft Weapons System." Under that contract, one of the systems incorporated the Fiberglass wrapped self-contained chamber round having T154 ballistics.

Next, Olin was awarded another contract, the purpose of which was to fabricate and fire a limited number of fiberglass rounds to evaluate the feasibility of this round configuration.

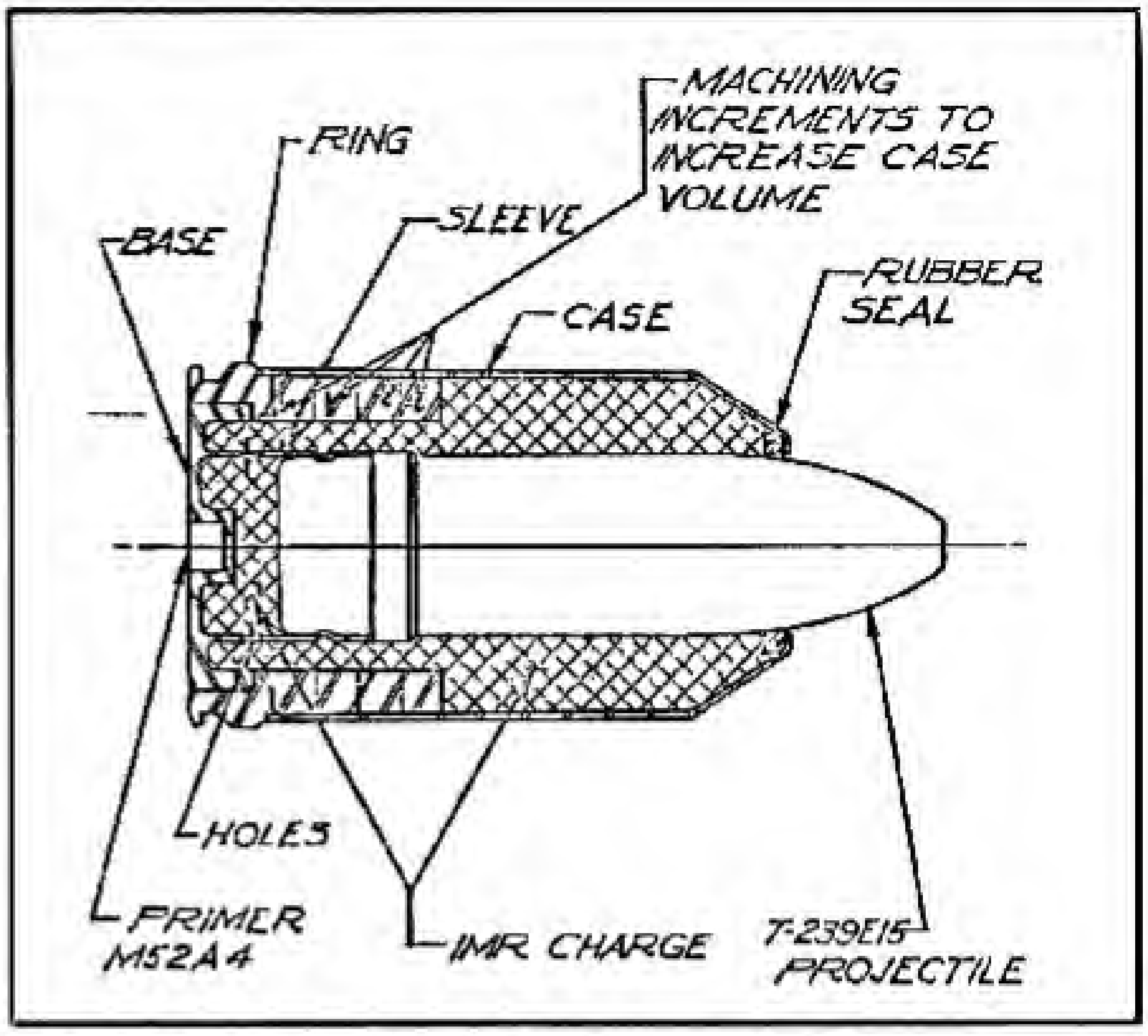
A fiberglass wrapped self-contained chamber, shrouded, 30mm round with a 3900 grain 30mm projectile was designed and subjected to limited testing. The results obtained indicated that the self-contained firing chamber was feasible.

The purpose of the original Olin firing test was first, to establish whether a fiberglass reinforced self-contained chamber was feasible and second, to establish the wall thickness necessary under high dynamic stress conditions in an attempt to determine design criteria for further study.

All work ceased August 30, 1957.

Characteristics of Aircraft Armament, Inc.'s 30mm Telescoped Round

Projectile	30mm (4900 grains)
Propellant Type	IMR 4996
Muzzle Velocity	3115 fps
Projectile Travel	48 inches
Maximum Chamber Pressure	48,000 psi
Case Colume	8.5 cubic inches
Muzzle Pressure	11,000 psi
Charge Weight	1990 grains
Loading Density	0.93
Length (overall)	5.00 inches
Maximum Diameter	2.187 inches
Round Weight (with Aluminum Case)	1.14 pounds
Primer (Electric)	M52A4



Aircraft Armament, Inc.'s 30mm Telescoped Round

SECTION V. AIRCRAFT ARMAMENTS, INC.

History

The primary objectives of the original contract scope were the preliminary design of an automatic aircraft gun mechanism and the development of the related ammunition. This work was done in the period from 21 September 1955 until notice of redirection on 23 February 1956.

During the course of this program, the AAI's design efforts followed the requirements of the Air Force Exhibit WCLG-709, dated 25 June 1954, entitled "Gun, Automatic, 30mm, T154."

On January 31, 1956, the T154 Steering Committee held a conference at Springfield Armory. During this conference, all of the contractors and Government agencies involved in the T154 program were allowed to present the results of their various development efforts. AAI presented the 30mm telescoped round and compatible gun design. As a result of the Steering Committee Evaluation, several contractors were requested to terminate their efforts at that time. However, Springfield Armory was directed to alter the original course adopted by AAI. AAI was requested to discontinue any further development of this approach and to follow a new approach as given under AAI Second Approach T154.

AAI was informed by the Springfield Armory that the reasons for this redirection were as follows: Excessive ammunition weight and excessive dynamic loads on the small gun components at 2000 rpm of a single barrel gun.

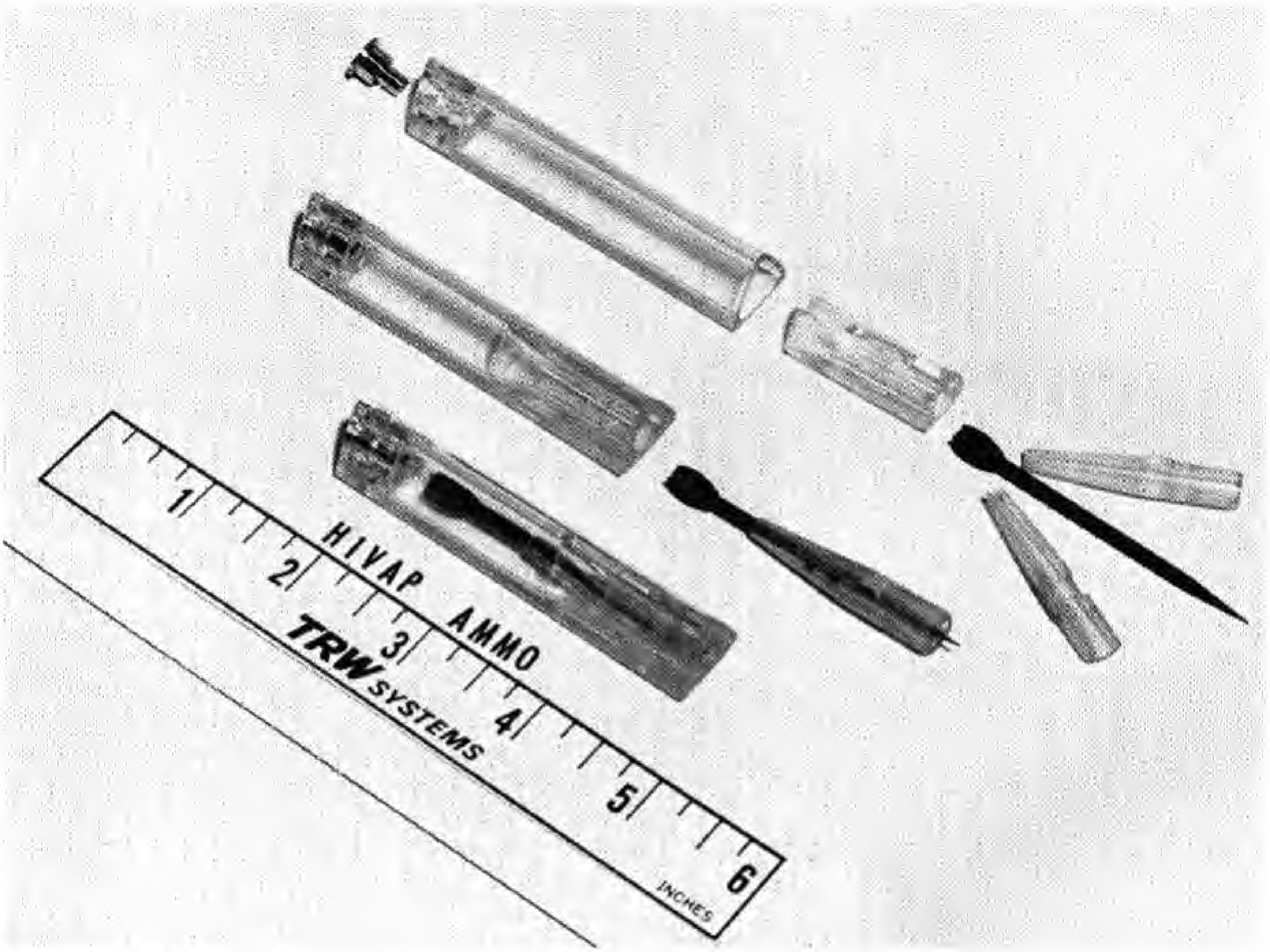
SECTION VI. TRW

History

Based upon the requirements for the Large Calibre Caseless Ammunition Weapon System, as specified by the U.S. Army, TRW developed and refined concepts (Concept and Fesibility Study for an Automatic Weapon Capable of Repetitive Fire of Caseless Ammunition) and (Continued Studies For and Automatic Caseless Ammunition Weapon System) from 24 July 1967 through 17 April 1969.

The effort resulted in a preliminary design of an engineering model which is the TRW Rotary Feed Weapon Design, a short recoil, gas accelerated, sliding sleeve concept, utilizing a rotary feed mechanism.

By the early 1970's all interest in the development ceased.



Open Chamber Ammunition

SECTION VII. LATEST ATTEMPTS

Today the Open Chamber Principle is used in well-drilling equipment.

"The gun fires salvos of ceramic projectiles at high speeds, 4,500 feet per second," says David Dardick, president of Tround International. "And they never strike at exactly the same time."

The alumina "bullets" don't penetrate the rock. "They disintegrate into dust on impact without damaging the drill bit," says Dardick. But as they slam into the rock, microseconds apart, the bullets create shock waves. The stress waves from each impact interact, producing thousands of tiny cracks in the rock, fracturing the rock before the drill bit gets to it.

Chapter 70

THE JUNKER SYSTEM

It is a commonly expressed point of view of historians that nothing new can be done in gun design unless a new form of ammunition is developed.

Existing automatic weapons are case-dependent, in that the case is a key precision instrument of the locking ignition format as well as performing other important functions.

Historically, modern repeating arms evolved around metal cartridge cases. While this proved to be ideal for loading all the ingredients of a given shot simultaneously, most automatic weapon malfunctions relate to the case.

When the internal combustion engine came on the scene, metal cased ammunition was already established for automatic gun use. Considering the fact that guns, like their internal combustion counterparts, must use flammable fuels to propel them, and that safe storage of and timely insertion or injection of fuel into the furnace are critical to practical systems — it seems logical to apply the best examples of internal combustion engines to automatic air-cooled weapons where heat build-up is a natural consequence of rapid fire.

It would seem logical to:

- optimize conditions in the gun for cooling between shots;
- develop cooler burning propellants;
- withhold fuels from contact with hot metal until other conditions for ignition are met (time of contact down);
- minimize fuel contact with hot metal in the chambering stroke (less physical contact).

Furthermore, it seems logical to store the percussion sensitive ignition charge in a compartment separate from the flammable propellant charge.

These conditions are all met in the Junker Systems approach to eliminating the need for cased ammunition.

Junker Systems, a pathfinder R & D company, believed it had found the correct route to pursue.

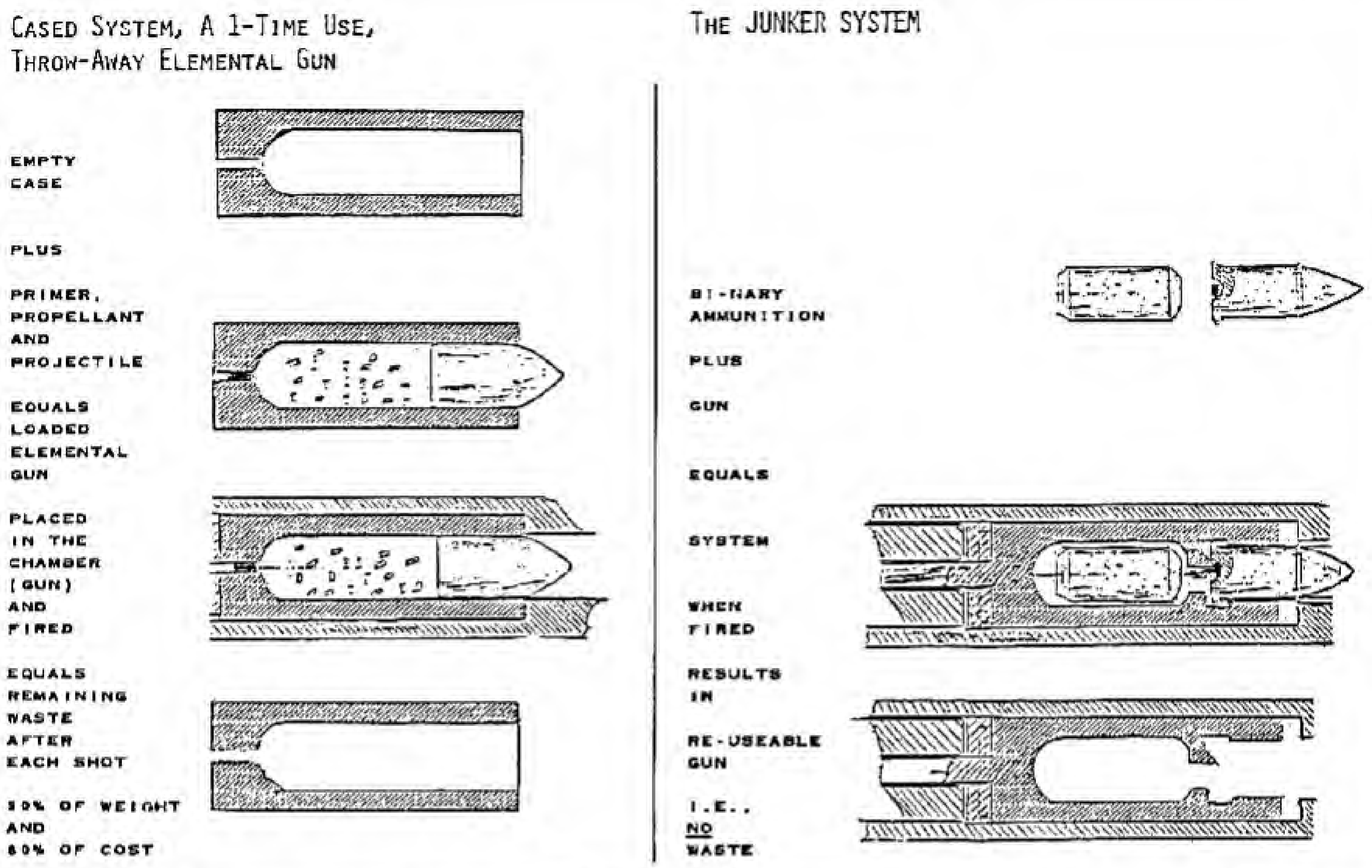
Ralph D. Junker, Originator, Junker System

In order to meet the safety requirements for safe storage and loading of round ingredients, it has been necessary to move the traditional percussion sensitive primer to a protected location in the base of the projectile, and to develop a separately stored and loaded solid fuel propellant charge.

Accordingly, the Junker Systems cartridge does not meet the definition of "caseless."

Built into the Junker gun is a reuseable metal case.

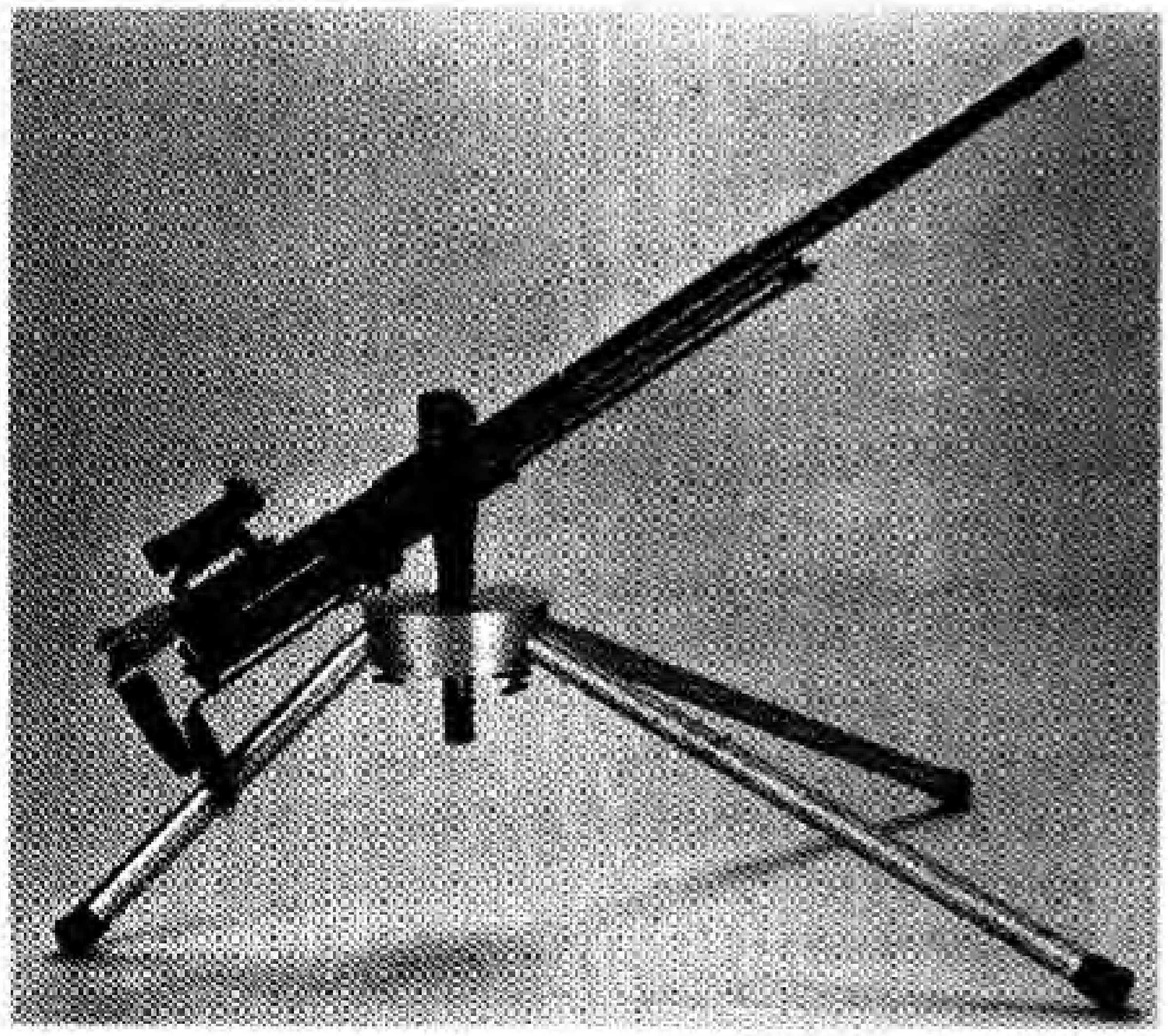
The ammunition is separate-loading with solid fuel propellant, and with percussion sensitive primer moved to a safe location in the base of the steel


CASED SYSTEM, A 1-TIME USE,
THROW-AWAY ELEMENTAL GUN
EMPTY CASE
PLUS
PRIMER, PROPELLANT AND PROJECTILE
EQUALS LOADED ELEMENTAL GUN
PLACED IN THE CHAMBER (GUN) AND FIRED
EQUALS REMAINING WASTE AFTER EACH SHOT
50% OF WEIGHT AND 60% OF COST
THE JUNKER SYSTEM
BI-NARY AMMUNITION
PLUS
GUN
EQUALS
SYSTEM
WHEN FIRED
RESULTS IN
RE-USEABLE GUN
I.E., NO WASTE

Comparison of Used Ammunition and the Junker System

projectile.

Primer and propellant are isolated from each other until ignition is intended.



Junker System's Prototype Gun

Designs are directed to self-loading machine guns interrupting fire with the bolt open.

"Caseless" has come to mean "consumable cased ammunition."

In "Caseless" ammunition programs, the propellant was required to function as ramrod and an extension of the extractor.

These load-bearing functions were met in two ways:

(a) by creating a consumable outer case; or
(b) by gluing the propellant, projectile and primer together in a consolidated mass.

If a consumable outer case were used for granular propellants, the granular propellants and projectile would leave the system before the outer tube was consumed.

In practice, it proved necessary to fracture the consumable cased structure into a myriad of like-sized particles to insure that they would burn out before an autoloading, aftercoming round could reach the chamber. This fragmentation was best accomplished by getting everything together into a

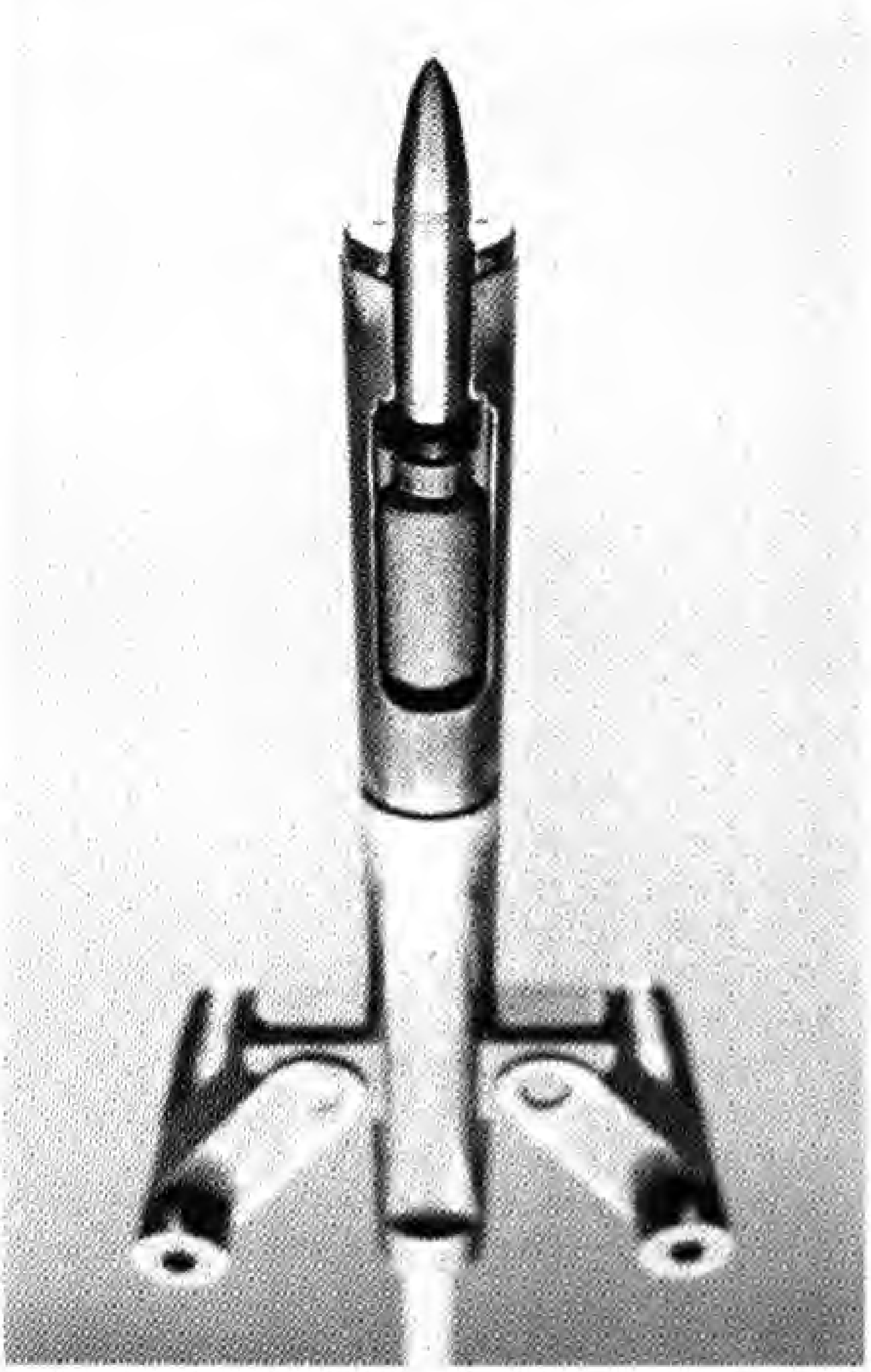
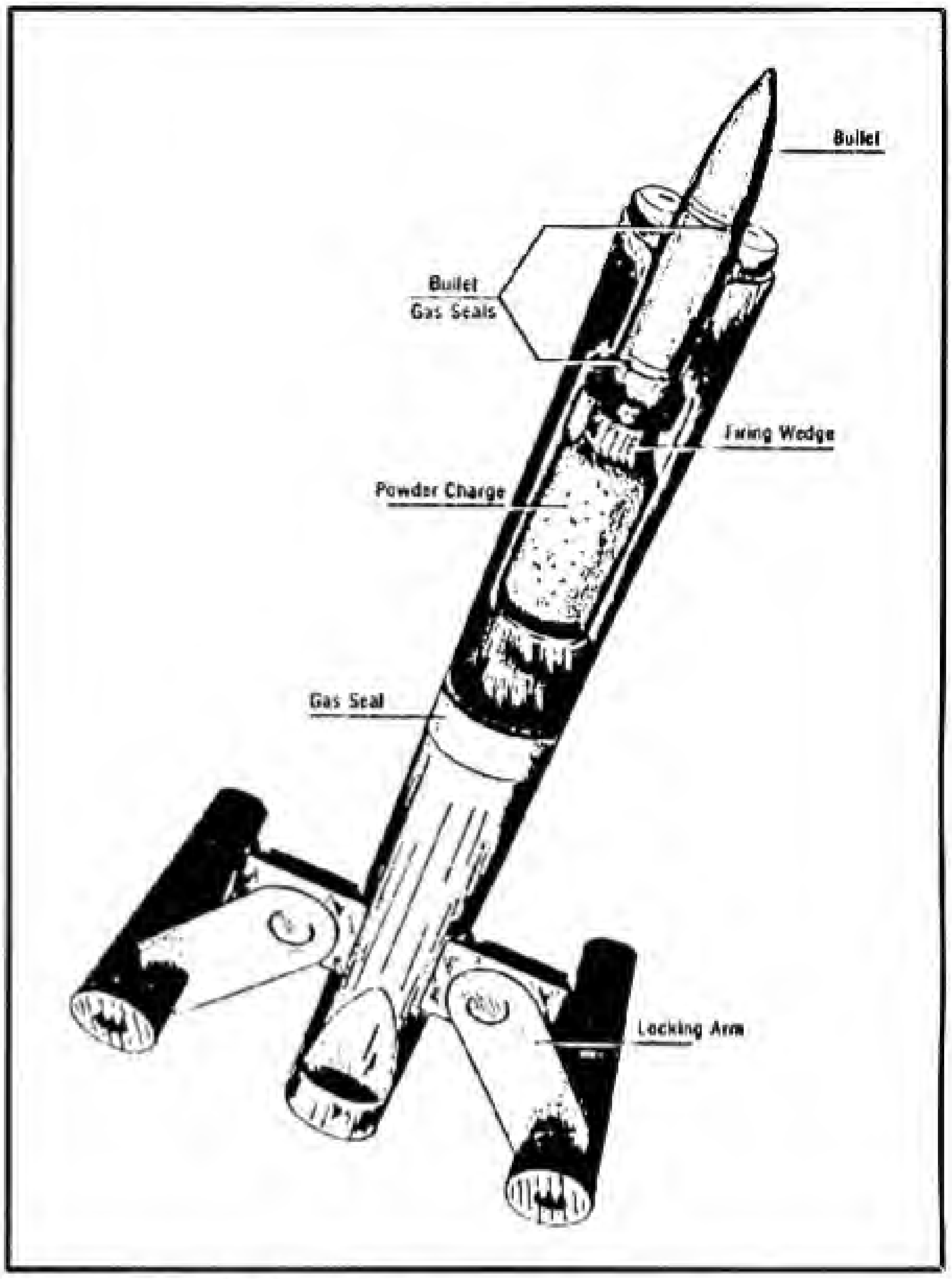


Photo of Junker Systems' Locking System



Schematic of Locking System

consolidated single mass.

Unfortunately, propellant structure of adequate strength for load bearing would have to be broken up into like-sized particles by an internal explosion of considerable intensity.

In either instance, the concept of a consumable cased round for autoloading guns has proven to be impractical for safety reasons.

In one instance, there would be hot smoldering residues which could ignite the aftercoming round; in the other, the ammunition would be unsafe in the magazine because if the round must explode to function properly in the chamber, it could and would explode in the magazine with actuation of the high explosive ignition train from any penetrating blow.

The concept of consumable case ammunition is rejected.

After all, the objective is not simply to substitute one case for another, but rather to avoid the requirement for any kind of casing on the individual rounds.

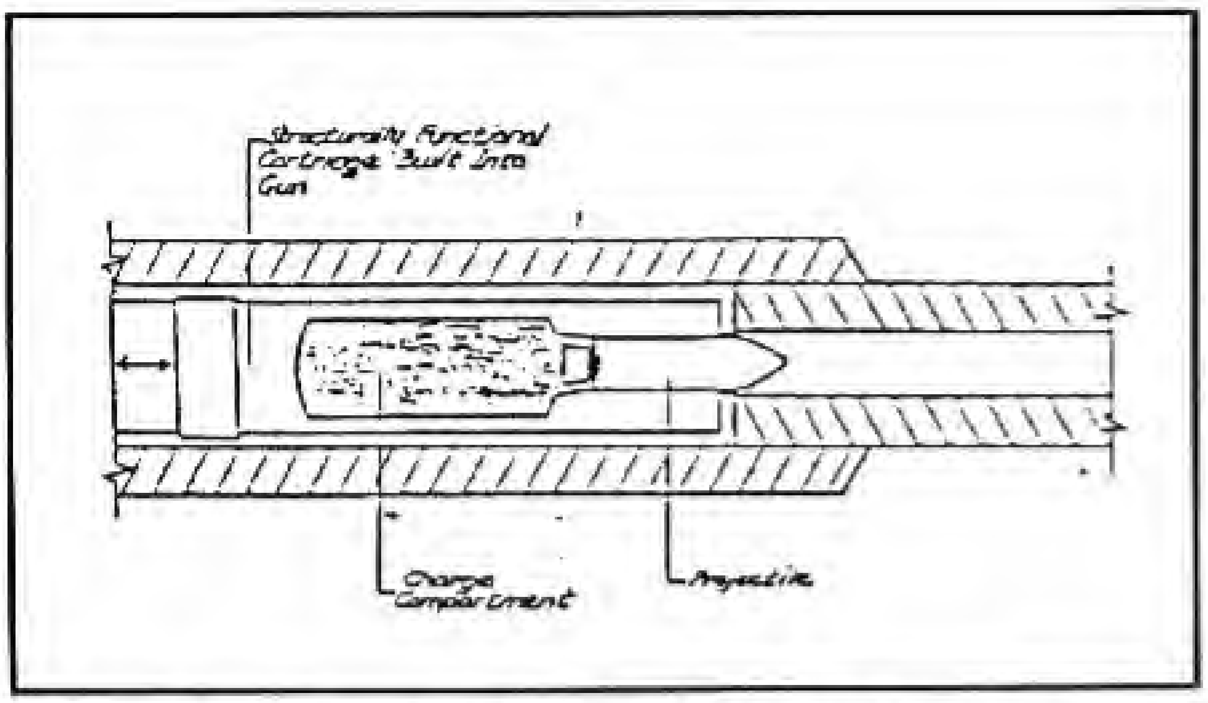
The prime objective of eliminating the need for cartridge cases of any kind is met in the Junker System where the bolt head assumes the load bearing function for round transport and ignition.

This is truly non-cased ammunition with a functional reuseable metal case built into the gun!

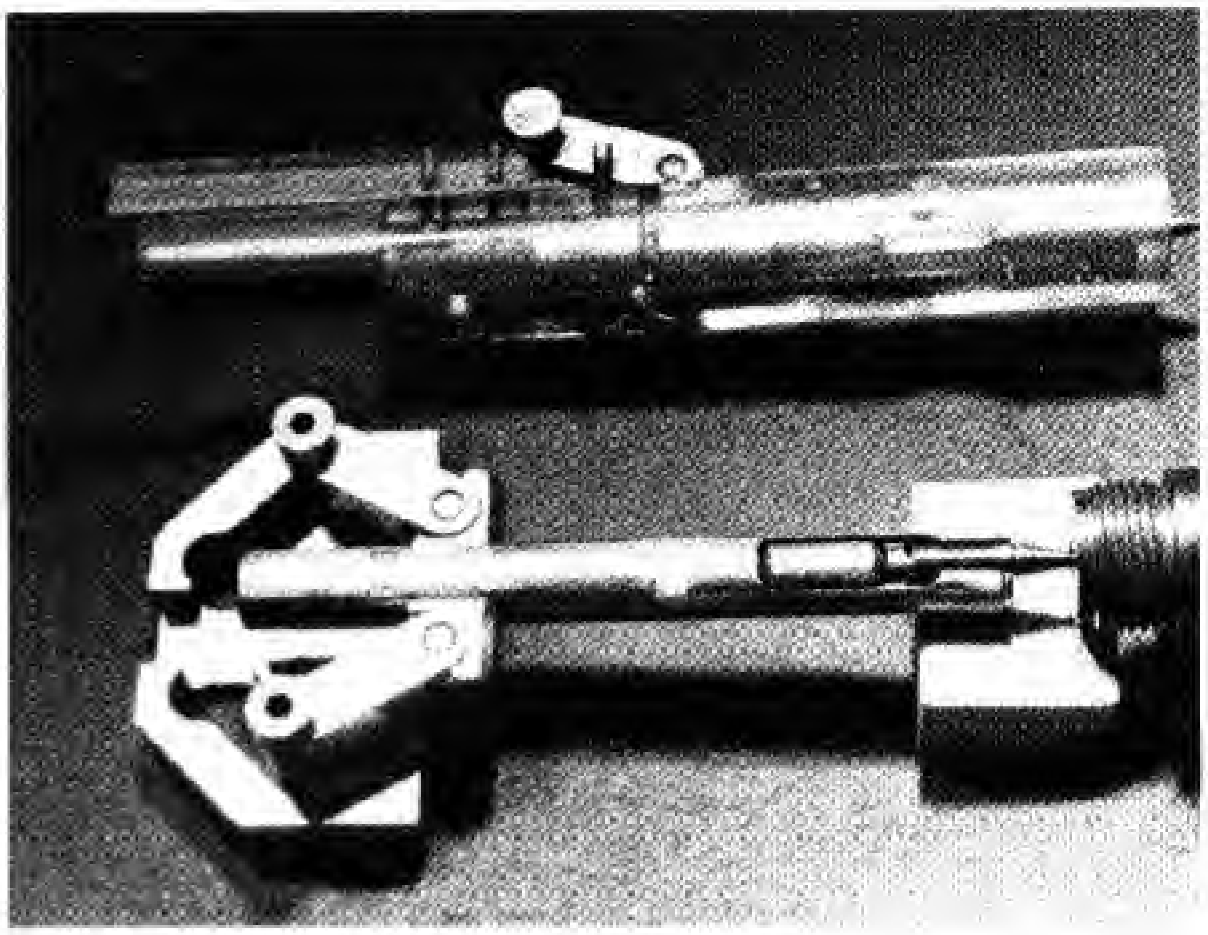
The advanced safety features of the Junker System offer advantages beyond any other gun designed to eliminate the use of metal case ammunition. At the same time it provides significant improvements in ammunition, a goal long pursued by the military.

Fully automatic rifle fire has created massive increases in the demand for ammunition supply — with attendant excessive waste. Quoting General John Murray:

> "In the blessed logistical trinity, what it takes to 'move-shoot-and-communicate' . . . the ultimate treasure is ammunition. An army without ammunition is impotent."



Junker System Reusable Case and Charge Compartment



Junker Locking System

While industry, by and large, has been satisfied with supplying traditional guns and ammunition, the military is clearly looking for more cost-effective weapon systems and the most dramatic and revolutionary guns can be made by finding practical means to eliminate the need for the costly, heavy, expendable metal case on each round of ammunition.

To date, efforts along these lines have only been partially successful.

While the feasibility of firing ammunition without cases has been proven, all prior efforts to apply this approach to automatic weapons have been instituted only at the expense of safety - an unacceptable compromise.

The United States military is openly committed to finding safer forms of caseless ammunition and is now looking at the possibilities that their specifications have been too narrowly written, attempting to marry the self-contained, one-part, fixed caseless ammunition specifically to selective fire rifles (which interrupt firing with a round in the chamber). There is a growing understanding that the barriers found in mating this ammunition to rifles can be overcome in machine guns (which have independent fuel injection).

In order to eliminate the metal case (and still have a self-contained package) it becomes necessary for the propellant to be altered to transport the heavy projectile and provide rigid anvil support for primer ignition.

This starts a chain reaction of consequences.

Reinforced propellant structures have to be destroyed in the same time frame that a pure propellant will burn in the bore. In order to do this with traditional base ignition, the consolidated propellant charge will have to be blasted into a number of like-sized particles. This calls for some truly explosive ignition — with the natural consequence of:

1. sudden high pressure, and a
2. corresponding increase in temperature.

This form of boosted ignition makes the "caseless" round unsafe in the magazine because any ammunition designed to explode violently in the chamber can also explode in the magazine with actuation of any one ignition train inside a densely compacted charge by a small calibre bullet hit. This disseminates flaming particles capable of igniting all other rounds in the magazine.

The second danger is failure to clear the chamber of hot smoldering residues inviting premature ignition of the after-coming round.

The irony of this is that these invitations to trouble can be averted by the simple expedient of injecting the fuel as a separate entity from bullet and primer.

Based on experience with separate loading ammunition used in artillery, some researchers have been saying that once the metal case is eliminated it will be necessary to break up the package for safety reasons.

In artillery, the heavy projectile and primer are loaded independently from the propellant.

Accordingly, the propellant need perform only one function - that of propulsion. This avoids the conflict in purpose imposed upon the propellant in fixed "caseless" and calls attention to the fact that one of the secrets to success of cased ammunition is the fact that the propellant rides passively into and out of the chamber in its own compartment. In effect, the propellant is isolated from both projectile and primer and is ignited form an adjacent compartment in the conventional metal case.

This pattern can be reproduced in a lower cost, safer ammunition/gun design where a permanent cartridge case is built into the gun as an extension of the bolt head having lateral recesses for projectile and separate consolidated propellant charge.

This becomes a key safety feature of a new machine gun system — the Junker System.

In this new system the primer is moved to a protected location in the base of the metal projectile so that separate propellant cartridge and primed projectile do not meet anywhere in production or storage until they come together in the gun for firing. This is an important breakthrough in safe storage of ammunition and is the basis for new programs for binary (two-part) ammunition - superior safety.

In the binary formula, with separate fuel injection, other safety advantages have gradually become apparent.

A separately injected fuel need only have adequate strength to support its own weight and need not fill or conform to the chamber for ignition purposes.

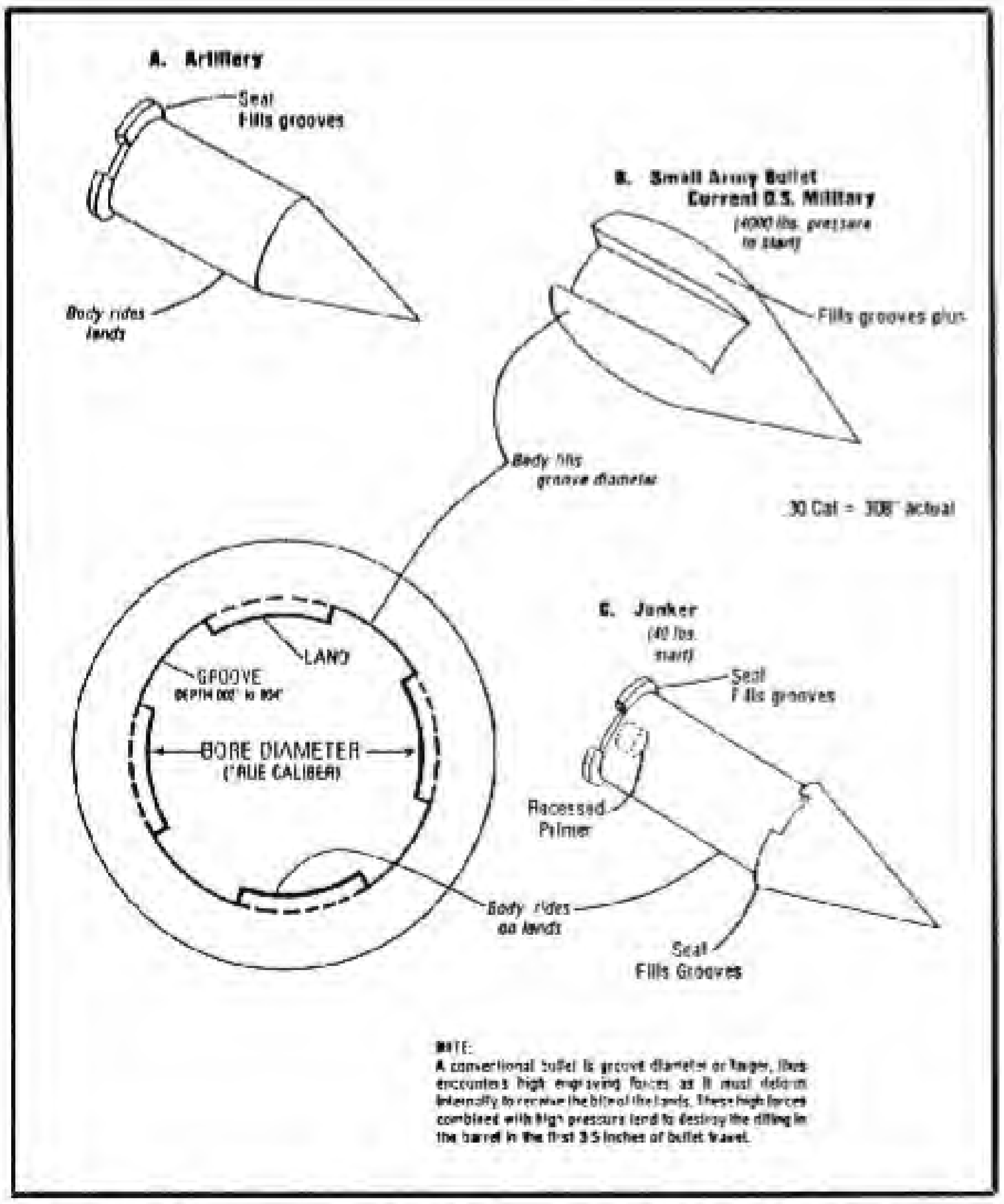
Accordingly, there will be no requirement for a structural load-bearing casing on the outside of the propellant cartridge. Therefore, thin thermal shields can be employed to provide short-term protection from "cook-off."

Once ignited, from a vulnerable core with free-flame passage surrounding the propellant cartridge, the outer thermal shield is enveloped in flame so that it vaporizes in the same time frame that the propellant burns in the bore.

In the Junker System it is recognized that a consolidated charge trapped in its own compartment and ignited from the front would force the projectile and charge in opposite directions prolonging the time interval that the propellant burns adjacent to the thermal shield and facilitating efficient chamber cleanout in a self cleaning swirl type action - a major improvement in safety.

In the Junker System ignition takes place when the projectile's forward motion is checked as it gas seals with the bore. The primer in the base of the bullet is driven back into firing wedges - igniting the primer and setting fire to the charge in a rearward compartment - thus there is no interference in the pry-apart reaction between bullet and the charge. This avoids the interference problem encountered when consolidated charges filling the chamber are ignited from the rear.

As the Junker System has evolved, it has become known that the military is looking for ways and means to improve machine gun ammunition. Basically, it has boiled down to the fact that instant response rifle ammunition has not been considered ideal for use in machine guns because it produces



NOTE:
A conventional bullet is groove diameter or larger, thus encounters high engraving forces as it must deform internally to receive the bite of the lands. These high forces combined with high pressure tend to destroy the rifling in the barrel in the first 3.5 inches of bullet travel.

Bore Start Representative Deformation from one Land

Calibre .50 and 20mm Cased Ammunition with Junker System Consolidated Charges at Full Capacity of Case more erosion at the throat of the bore - and dangerous muzzle flash.

Part of the problem has been the fact that the starting loads for a conventional rifle bullet are very high - in the neighborhood of 4,000 pounds pressure. This means that pressure peaks before the bullet has moved an appreciable distance.

In artillery practice, it is customary to use a bullet which gas seals externally - thus does not have to deform internally to accommodate the rifling lands as occurs in conventional small arms bullets (which are bigger than the hole they must travel through).

Accordingly, Junger System's bullets are designed with external rotating bands (similar to artillery) and, in the current calibre range, can begin traversing the bore at as little as 40 pounds of pressure.

This substantially lower pressure leaves room for slower starting ignition and, at the same time, permits use of progressively faster burning propellants to keep up with the accelerating bullet. This converts to longer sustained mean pressure at lower peak pressure - long considered an ideal goal in propellant development.

In artillery, it is customary to lead ignition flash from the primer through a flash tube to the front of the charge column. This tends to burn the propellant back in the barrel, leaving less unburned propellant to be discharged from the muzzle.

A proven means of reducing muzzle flash, one that is improved upon in the Junker System, is using a consolidated charge trapped in the rear chamber which can be engineered to burn in a controlled, but progressively faster manner, so that propellant is burned before reaching the muzzle.

The ability to burn the fuel in a controlled manner with easier-starting cooperative bullets moves the bullet well down the bore before pressures peak, yet allows a longer sustained mean pressure which gives the bullet its thrust.

Reduction of peak pressures, and movement of peak pressures well down the bore, tends to spare the throat of the bore from the kind of rapid erosion which occurs with conventional rifle ammunition.

Test Results

To prove the theories involved, an experimental one-shot weapon was constructed by the U.S. Army's Ballistics Lab at Aberdeen, Maryland, and tested under the most exacting conditions with the latest instrumentation.

In the testing of any weapon, one of the key figures is kinetic energy out the end of the barrel. Test firing at BRL and other independent laboratories demonstrated that the same, or better, muzzle energy output could be achieved by the Junker System - and at substantially lower peak pressures than other military bullets from NATO or the Warsaw Pact.

The most dramatic comparisons are, however, between consolidated charges ignited from the rear (fixed "caseless") and Junker System's consolidated charges ignited from the front where the same energy output can be achieved at half the peak pressure.

Only recently has the potential of front ignition of consolidated charges become appreciated for its potential of achieving the maximum velocity at lower peak pressures.

It appears that conventional ammunition ignited from the rear has an interference problem sending a series of traveling charges along the bore with the bullet. Late ignition of these charges creates head-on collisions with after-coming gasses, thus downgrading the system's efficiency.

The Junker System is similar to a solid propellant rocket with unidirectional gas flow from the chamber. Thus, there are no late igniting solids in the bore to interfere with gas flow.

The Junker System is designed primarily for use in machine guns where fuel injection is the common firing mode - as compared to automatic rifles which may interrupt fire with a round cooking in the chamber.

A further reason for selective application to machine guns centers on the verified observation that ammunition may be used more economically in fully automatic fire if the gunner can visualize the stream of fire and "walk" it to the target. Fully automatic fire from rifles has been declared largely wasteful of ammunition as compared to tracer-directed machine gun fire.

Historically, machine gun sweep fire has been the pre-eminent defense weapon along a line or perimeter, changing the history of warfare, while many consider the hand-held, fully automatic rifle to be the creator of shortages of ammunition - with poor return.

Accordingly, many attempts to return to the controlled sweep-fire identified with the machine gun and return the machine gun to its historical role as the primary defense weapon, particularly since this can now be accomplished at half the weight and half the cost of conventional ammunition. Reducing the weight of ammunition by half (as "caseless" ammuniton will do) effectively doubles the available transport - an important reason for pursuing all avenues of research to eliminate the need for metal cases. As such, it is hoped that a new breakthrough in ammunition - as proposed in the Junker System -offering low cost, lightweight, and far-reaching economic ramifications can be reached.

PART XVII

RELEVANT PATENTS IN PUBLIC DOMAIN 1952-1971

CHRONOLOGICAL LISTING OF PATENTS
BY YEAR OF OFFICIAL GAZETTE

January 11, 1955

2,699,006; FIREARM OF THE REPEATER GUN TYPE; Mikkel Maerk, Lokken Verk, Norway; Application April 28, 1948, Serial No. 23,765; Claims priority, application Norway May 13, 1947; 7 Claims. (Cl. 42–10).

2,669,007; REPEATER GUN; Mikkel Maerk, Lokken Verk, Norway; Application April 22, 1952, Serial No. 283,710; Claims priority, application Norway May 13, 1947; 12 Claims. (Cl. 42–11).

2,669,008; FIREARM; John D. Tyler, Nashville, Tenn.; Application August 17, 1949, Serial No. 110,805; 7 Claims. (Cl. 42–57).

2,699,094; RIFLED FIREARM WHICH AUTOMATICALLY INDEXES PREENGRAVED PROJECTILES; Clarence Walton Musser, Philadelphia, Pa.; Application February 19, 1947, Serial No. 729,638; 7 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 1, 1955

2,700,839; PATTERN CONTROL DEVICE FOR SHOTGUNS; Walter L. Finlay, Fairfield, Robert T. Catlin, Stratford, and Gilbert E. Hutchinson, Nicholas; Conn., assignors to Remington Arms Company, Inc., Bridgeport, Conn.; a corporation of Delaware; Application September 9, 1950, Serial No. 183,996; 3 Claims. (Cl. 42–79).

February 8, 1955

2,701,504; FEEDING MECHANISM FOR AUTOMATIC FIREARMS; Wilbur A. Schalch, Franklin, Mich.; Original application November 10, 1948, Serial No. 59,324. Divided and this application January 17, 1951, Serial No. 206,411; 3 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 15, 1955

2,701,931; FIRING MECHANISM FOR GUNS; John Polay, Elizabeth, N. J.; Application September 5, 1952, Serial No. 308,068; 9 Claims. (Cl. 42–69).

March 1, 1955

2,702,958; BARREL MOUNT FOR FIREARMS; Brunson V. Boroszewaki, Buffalo, N. Y.; Application May 27, 1954, Serial No. 432,823; 7 Claims. (Cl. 42–75).

March 16, 1955

2,703,943; SAFETY-MEANS FOR THE HALF-COCK NOTCH OF EXPOSED HAMMER FIREARMS; William C. Roemer, New Haven, Conn., assignor to Olin Mathleson Chemical Corporation, a corporation of Virginia; Application April 26, 1951, Serial No. 222,986; 5 Claims. (Cl. 42–70).

March 22, 1955

2,704,489; SERVO SYSTEM FOR AIRCRAFT TURRETS; Edmund B. Hammond, Jr., Brooklyn, Willis G. Wing, West Hempstead, and F. Norton Williams, Jr., Forest Hills, N. Y., assignors to The Sperry Corporation, a corporation of Delaware; Application April 17, 1943, Serial No. 483,532; 24 Claims. (Cl. 89-41).

2,704,490; FIRE CONTROL SYSTEM FOR AIRCRAFT GUNS; Edmund B. Hammond, Jr., Brooklyn, N. Y., assignor to the Sperry Corporation, a corporation of Delaware; Application June 16, 1943, Serial No. 490,975; 28 Claims. (Cl. 89–41).

2,704,491; SELF-LOADING FIREARM WITH PIVOTED LOCK RELEASED BY INERTIA MEMBER; Goffredo Prola and Carlo Prola, Rome, Italy; Application May 31, 1950, Serial No. 165,194; Claims priority, application Italy March 16, 1950; 3 Claims. (Cl. 89–182).

April 19, 1955

2,706,356; MULTI-BULLET MACHINE GUN BARREL; Victor A. De Vita, Brooklyn, N. Y.; Application April 2, 1951, Serial No. 218,726; 3 Claims. (Cl. 42–76).

May 17, 1955

2,708,390; **DISINTEGRATING CARTRIDGE BELT LINK**; Burns Darale, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application December 23, 1953, Serial No. 400,147; 5 Claims. (Cl. 89–35).

2,708,391; **LOADING APPARATUS FOR ORDNANCE**; Desmond Walter Molins, John Charles Haysom, and James Arthur Mason, London, England; Application September 26, 1951, Serial No. 248,291; Claims priority, application Great Britian October 3, 1950; 8 Claims. (Cl. 89–45).

May 24, 1955

2,708,805; **EJECTOR DEVICE FOR AUTOMATIC FIREARMS WITH REVOLVER DRUMS**; Theodore Schneider, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Application March 22, 1951, Serial No. 216,863; 2 Claims. (Cl. 42–68).

June 7, 1955

2,709,948; **UNIVERSAL TYPE GUN MOUNT**; John Victor Jackson, Bristol, England, assignor to The Bristol Aeroplane Company Limited, Bristol, England, a British company; Application January 21, 1950, Serial No. 139,915; Claims priority, application Great Britian January 27, 1949; 10 Claims. (Cl. 89–37.5).

June 14, 1955

2,710,476; **MAGAZINE LATCHING SYSTEM**; John C. Garand, Springfield, Mass.; Application June 6, 1946, Serial No. 674,698; 2 Claims. (Cl. 42–18); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,710,477; **UNITARY RAMMER-EJECTOR FOR FIREARMS**; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 16, 1953, Serial No. 331,755; 5 Claims. (Cl. 42-25); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,710,561; **AMMUNITION BOX**; Albert A. Dowd, Middle River, Md., assignor to The Glenn L. Martha Company, Middle River, Md., a corporation of Maryland; Application February 18, 1950, Serial No. 144,940; 5 Claims. (Cl. 89–34).

2,710,562; **GUN MOUNTING ARRANGEMENT FOR AIRPLANES**; Gordon P. Gravenhorst, Middle River, Md., assignor to The Glenn L. Martha Company, Middle River, Md., a corporation of Maryland; Application July 15, 1949, Serial No. 104,858; 11 Claims. (Cl. 89–37.5).

July 5, 1955

2,712,192; **EXTRACTION, EJECTION AND RAMMING MECHANISM**; Paul H. Dixon and Maynard B. Wallin, Rockford, Ill., assignors to the United States of America as represented by the Secretary of the Army; Application October 2, 1951, Serial No. 249,276; 8 Claims. (Cl. 42-25).

2,712,193; **SHOT GUN MUZZLE DEVICE**; William F. Mathis, Hollywood, Calif.; Application May 3, 1951, Serial No. 224,425; 2 Claims. (Cl. 42–79).

2,712,271; **ADJUSTABLE SUPPORT APPARATUS**; Richard E. Wabnitz, Brussels, Belgium; Application June 8, 1953, Serial No. 360, 134; Claims priority, application Switzerland May 7, 1949; 12 Claims. (Cl. 89–41).

July 12, 1955

2,712,705; **FIREARM CARTRIDGE PROTECTOR**; Horace St. Amant, Cheshire, Conn., assignor to Olin Mathleson Chemical Corporation, a corporation of Virginia; Application May 22, 1952, Serial No. 298,281; 5 Claims. (Cl. 42–50).

July 19, 1955

2,713,227; **EXTRACTOR AND LOADING MEANS FOR FIREARMS**; Horace Will Smallwood, Four Oaks, England, assignor to Webley & Scott Limited, Birmingham, England, a British company; Application October 20, 1952, Serial No. 315,710; 3 Claims. (Cl. 42–25).

2,713,288; **ELECTRIC AMMUNITION FEEDER**; James C. Elms, Dayton, Ohio; Application December 18, 1945, Serial No. 635,814; 4 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 2, 1955

2,714,332; **RECOIL AMPLIFIER FOR MACHINE GUNS**; Erik Saetter-Lassen, Gentofte, near Copenhagen, Denmark; Application September 21, 1950, Serial No. 185,936; Cliams priority, application Denmark November 1, 1949; 4 Claims. (Cl. 89–14).

2,714,333; LINK METALLIC BELT; Paul H. Dixon, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application February 14, 1952, Serial No. 271,564; 4 Claims. (Cl. 89–35).

2,714,334; BREECH BOLT LOCK FOR AUTOMATIC FIREARMS; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of Army; Application February 11, 1949, Serial No. 75, 921; 3 Claims. (Cl. 89–190); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 9, 1955

2,714,836; PERCUSSION MECHANISMS FOR FIRE ARM; Joseph Raymond Jasse, Paris, France, assignor to Societe Nouvelle des Etablissements Brandt, Paris, France, a French body corporate; Application March 3, 1950, Serial No. 147,527; Claims priority, application France March 15, 1949; 3 Claims. (Cl. 89–27).

August 16, 1955

2,715,290; MAGAZINE FOR AUTOMATIC FIREARMS; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of War; Application April 21, 1949, Serial No. 88,875; 1 Claim. (Cl. 42–50); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,715,355; FIRE CONTROL MECHANISM; John C. Garand, Springfield, Mass.; Application July 23, 1945, Serial No. 606,699; 28 Claims. (Cl. 89–140); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,715,356; CLOSING BLOCK WITH PERCUSSION SAFETY FOR AUTOMATIC GUNS; Sestilio Florini, Brescia, Italy, assignor to Societa Italiana Ernesto Breda per Costruzional Meccamiche, Milan, Italy; Application March 9, 1950, Serial No. 148,549; Claims priority, application Italy March 7, 1949; 1 Claim. (Cl. 89–164).

August 23, 1955

2,715,856; INCLOSED CONCENTRIC RECOIL MECHANISM TO FACILITATE REPLACEMENT OF GUN TUBES; Alexander E. Kramer, Hyattsville, Md., and Herman A. Matson, Washington, D. C., assignors to the United States of America as represented by the Secretary of the Army; Application May 11, 1951, Serial No. 225,904; 5 Claims. (Cl. 89–43); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,715,857; BOLT DETENT FOR A FIREARM; Burns Darale, Watertown, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application January 19, 1953, Serial No. 332,133; 6 Claims. (Cl. 89–181).

2,715,858; REGULATOR MEANS FOR A FIREARM GAS PISTON; Filser D. Hoppert, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 2, 1953, Serial No. 339,946; 3 Claims. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 6, 1955

2,716,923; FIRING MECHANISM FOR A RIFLE; Alonzo F. Galdos, Redwood City, Calif.; Original application February 1, 1950, Serial No. 141,801. Divided and this application December 8, 1952, Serial No. 324,857; 4 Claims. (Cl. 89–140); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 13, 1955

2,717,464; BREECH BLOCK FOR FIREARMS; Antonio Marcati, Buenos Aires, Argentina, assignor to Gildo Marcati, Buenos Aires, Argentina; Application May 21, 1951; Serial No. 227,403; 3 Claims. (Cl. 42–16).

2,717,465; CRADLE MOUNT FOR A GUN BARREL; Samuel Clark, Jr., Waterville, Maine, and Gerald R. Douglas, Charleston, W. Va.; Application June 7, 1951, Serial No. 230,368; 14 Claims. (Cl. 42–75).

2,717,532; COCKING DEVICE FOR SELF-LOADING FIREARMS; Robert Ramseyer, Geneva, Switzerland, assignor to the Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Switzerland; Application April 5, 1951, Serial No. 219,358; Claims priority, application Luxemburg April 15, 1950; 2 Claims. (Cl. 89–1).

2,717,535; BOLT FOR A FIREARM; Cecil H. Taylor, New Milford, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application November 19, 1951, Serial No. 257,011; 6 Claims. (Cl. 89–184).

September 20, 1955

2,718,081; TOGGLE TRIGGER MECHANISM; Earl L. Hardgrave, Midland, Tex.; Application February 20, 1953, Serial No. 337,911; 9 Claims. (Cl. 42–69).

October 4, 1955

2,719,375; FIREARM WITH A PAIR OF ACTION BARS; Lexie R. Crittendon; Wilmington, Del., and Phillip R. Haskell; Fairfield, Conn.; Bridgeport, Conn.; a corporation of Delaware; Original application January 31, 1950; Serial No. 141,532;

now Patent No. 2,645,873; dated July 21, 1953; Divided and this application January 7, 1953; Serial No. 330,002; 6 Claims; (Cl. 42–17)

2,719,458; **ELECTRICALLY FIRED PERCUSSION PRIMER**; Albert M. Stott; Aldan, Pa.; Application May 31, 1950; Serial No. 165,283; 1 Claim; (Il. 89–28)

2,719,459; **AMMUNITION BOOSTER**; Paul F. Peterson; Palos Verdes Estates, Calif.; assignor to North American Aviation, Inc.; Application June 13, 1949; Serial No. 98,799; Claims; (Cl. 89–33)

2,719,460; **BENCH REST RIFLE**; Wayne E. Leek; Dion, N.Y.; assignor to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Application March 28, 1952; Serial No. 279,006; 11 Claims; (Cl. 89–37)

October 18, 1955

2,720,819 **MAGNETIC RECOIL MECHANISM FOR GUNS**; James H. Ryan; Morristown, Tenn.; and Donald P. Smith; Maryland Park, Md.; assignors to the United States of America as represented by the Secretary of the Army; Application May 25, 1951; Serial No. 228,350; 1 Claim; (Cl. 89–43)

2,720,820 **HYDRAULIC BREECH OPERATING MECHANISM**; Paul H. Dixon and Donald E. Rutter; Rockford, Ill.; assignors to the United States of America as represented by the Secretary of the Army; Application June 2, 1950; Serial No. 165,814; 7 Claims; (Cl. 89–173)

November 1, 1955

2,722,074 **HAMMER ACTION FOR FIREARMS**; Theodore M. Bray, Jr., and Richard H. Weichsel; Hudson, Ohio; Original application May 16, 1950; Serial No. 162,212; now Patent No. 2,685,143; dated August 3, 1954; Divided and this application May 21, 1954; Serial No. 431,328; 2 Claims; (Cl. 42–69)

November 8, 1955

2,722,865;**MAGAZINE MOUNTING MEANS FOR AUTOMATIC FIREARMS**; Bernard Mallard; Geneva, Switzerland; assignor to Society "Brevets Aero-Mechaniques"; S.A.; Geneva, Switzerland; a society of Switzerland; Application July 3, 1952; Serial No. 297,059; Claims priority; application Luxembourg; July 10, 1951; 6 Claims; (Cl. 89–33)

November 29, 1955

2,724,997; **LOADING TRAY ARRANGEMENT FOR A RECOILING AUTOMATIC FIREARM**; Arent Gustav Carlsson; Kariskoga, Sweden; a corporation of Sweden; Application April 27, 1951, Serial No. 223,243; Claims priority, application Sweden April 28, 1950; 11 Claims; (Cl. 89–33)

December 6, 1955

2,725,655; **CARTRIDGE EJECTOR**; Bernard Maillard; Geneva, Switzerland; assignor to "Brevets Aero-Mechaniques;" Geneva, Switzerland; a society of France; Application November 23, 1951; Serial No. 257,690; Claims priority; application Luxembourg; November 25, 1950; 1 Claim; (Cl. 42–25)

2,725,791; **CASE EJECTOR FOR GUNS**; Gordon P. Gravenhorst; Middle River; and Henry H. Franz and William A. Snow; Baltimore; and Walter I. Black; Middle River, Ms.; assignors to The Glenn L. Martin Company; Middle River, Md.; a corporation of Maryland; Application November 14, 1949; Serial No. 127,082; 8 Claims; (Cl. 89–33)

January 17, 1956

2,730,928; **MACHINE GUN**; Erik Saetter-Lassen, Gentofte, Denmark; Application November 6, 1952, Serial No. 319,062; Claims priority, application Denmark November 17, 1951; 5 Claims. (Cl. 89–190).

January 24, 1956

2,731,753; **FIREARM WITH DEVICE FOR MOVING THE MUZZLE DOWNWARDLY**; Henry A. Mathieu, Willimantic, Conn.; Application March 26, 1949, Serial No. 83,639; 7 Claims. (Cl. 42–74).

2,731,754; **ADJUSTABLE CHOKE FOR DOUBLE BARRELED SHOTGUNS**; Clyde M. Gibson, Huntington, W. Va.; Application February 23, 1950, Serial No. 145,818; 2 Claims. (Cl. 42–79).

January 31, 1956

2,732,767; **FRICTION BRAKE FOR A GUN**; Heinrich Herlach, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a Swiss company; Application May 2, 1952, Serial No. 285,728; 2 Claims. (Cl. 89–44).

2,732,768; **BREECH-BOLT LOCKING MECHANISM FOR AUTOMATIC SHOTGUNS**; Walter E. Browning, Salt Lake City, Utah; Application January 21, 1952, Serial No. 267,341; 10 Claims. (Cl. 89–182).

2,732,769; **SUPPORTING MEANS FOR A FIREARM BARREL**; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application February 10, 1953, Serial No. 336,214; 5 Claims. (Cl. 89–191); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 7, 1956

2,733,529; **CYLINDER STOP FOR A REVOLVER**; William B. Roger, Greens Farms, Conn., assignor to Sturm, Ruger and Company, Inc., Southport, Conn., a corporation of Connecticut; Application July 28, 1953, Serial No. 370,732; 3 Claims. (Cl. 42–67).

2,733,639; **BREECH MECHANISM FOR HEAVY CALIBER RECOILLESS GUN**; Clarence Salton Musser, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of War; Application July 1, 1948, Serial No. 36,507; 7 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,733,640; **DISINTEGRATING CARTRIDGE BELT LINK**; Carl W. Gilligan, Swift River, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application April 28, 1953, Serial No. 351,763; 5 Claims. (Cl. 89–35).

February 21, 1956

2,735,206; **BOX-MAGAZINE FOR FIREARMS**; Wallace B. Butler, Hamden, and Melvin M. Johnson, Jr., New Haven, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 6, 1950, Serial No. 199,430; 13 Claims. (Cl. 42–18).

February 28, 1956

2,736,117; **FIREARM WITH ALUMINUM BARREL AND RECEIVER**; Ralph E. Clarkson, Hamden, and Tuines W. van Wilgen, Bradford, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 18, 1951, Serial No. 262,281; 10 Claims. (Cl. 42–75).

2,736,118; **FIREARM WITH CHAMBER MEMBER REMOVABLE CONNECTED TO RECEIVER**; Ralph E. Clarkson, Hamden, and Tuines W. van Wilgen, Branford, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 18, 1951, Serial No. 262,282; 3 Claims. (Cl. 42–75).

2,736,119; **FIREARM HAVING CHAMBER MEMBER INTEGRAL WITH RECEIVER**; Ralph E. Clarkson, Hamden, and Tuines W. van Wilgen, Branford, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 18, 1951, Serial No. 262,283; 2 Claims. (Cl. 42–75).

March 20, 1956

2,738,710 **AIR FLOW RESTRICTOR FOR GUN PORT**; John H. Allen, Baltimore County, Md., assignor to The Glenn L. Martha Company, Middle River, Md., a corporation of Maryland; Application June 6, 1951, Serial No. 230,222; 7 Claims. (Cl. 89–37.5).

April 10, 1956

2,741,160; **HEAVY CALIBER RECOILLESS GUN**; Clarence Walton Musser, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of War; Application July 1, 1948, Serial No. 36,506; 7 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,741,161; **GUN FIRING MECHANISM WITH ECCENTRIC SAFETY**; C. Walton Musser, Philadelphia, Pa.; Application June 9, 1952, Serial No. 292,602; 15 Claims. (Cl. 89–28); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,741,162; **ELECTRONIC ANALOG SAFETY FOR AUTOMATIC WEAPONS**; Gordon B. Grans, Alexandria, Va., and Lafayette B. Hedge, Wood Acres, Md.; Application April 17, 1950, Serial No. 156,432; 8 Claims, (Cl. 89–135); (Granted under Title 35, U.S. Code (1952), sec. 266).

April 17, 1956

2,741,862; CARTRIDGE FEEDING MECHANISM; Harry H. Sefried II, New Haven, Conn.; Application September 26, 1950, Serial No. 186,751; 2 Claims. (Cl. 42–17).

2,741,950; RECOILING BARREL FIREARM WITH PIVOTED LOCK; Grover Cleveland Smith, Ogden, Utah; Application January 21, 1948, Serial No. 3,530; 17 Claims. (Cl. 89–176).

2,741,951; AUTOMATIC FIREARM; Paul de Kiraly, Ciudad Trujillo, Dominican Republic, assignor to The Hispaniola Corporation (La Hispaniola C. P. A.), Ciudad Trujillo, Dominican Republic, a firm of the Dominican Republic; Application June 6, 1950, Serial No. 166,454; Claims priority, application Switzerland June 11, 1949; 1 Claim. (Cl. 89–194).

April 24, 1956

2,742,727; SAFETY DEVICE FOR A FIREARM; Harry A. Asby, Jr., Grosse Pointe, Mich.; Original application October 24, 1947, Serial No. 781,860, now Patent No. 2,667,817, dated February 2, 1954. Divided and this application March 27, 1953, Serial No. 367,917; 3 Claims. (Cl. 42–70); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,742,821; VENT FOR TAPERED BORE GUN; Leroy R. Sweetman, Washington, D. C., assignor to the United States of America as represented by the Secretary of War; Application April 17, 1945, Serial No. 588,878; 2 Claims. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,742,822; FIRING MECHANISM FOR AUTOMATIC AND SEMI-AUTOMATIC FIREARMS; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of War; Original application February 11, 1949, Serial No. 75,921, now Patent No. 2,714,334, dated August 2, 1955. Divided and this application May 26, 1950, Serial No. 164,578; 7 Claims. (Cl. 89–140); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 8, 1956

2,744,448; AUTOMATIC PISTOL; Edward A. Allen, Westfield, Mass.; Application November 30, 1953, Serial No. 395,077; 12 Claims. (Cl. 89–196).

May 15, 1956

2,745,203; FIREARM CARTRIDGE PROTECTOR; Carl E. Ruple, Colorado Springs, Colo., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application May 20, 1952, Serial No. 288,815; 5 Claims. (Cl. 42–50).

May 22, 1956

2,746,357; FEED MECHANISM; Paul H. Dixon, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application April 14, 1950, Serial No. 155,893; 9 Claims. (Cl. 89–33).

May 29, 1956

2,747,313; BARREL TO RECEIVER CONNECTION ON A FIREARM; Lexie Ray Crittendon, Wilmington, Del., and William Gail, Jr., Ilion, N. Y., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application February 12, 1953, Serial No. 336,536; 2 Claims. (Cl. 42–75).

June 5, 1956

2,748,518; GRENADE LAUNCHER; Robert W. Moran, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application February 4, 1953, Serial No. 335,175; 2 Claims. (Cl. 42–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,748,661; FIRING RATE REDUCER FOR AUTOMATIC FIREARMS; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application December 10, 1952, Serial No. 325,239; 6 Claims. (Cl. 89–130); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,748,662; GAS REGULATING DEVICE FOR A FIREARM; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application November 7, 1952, Serial No. 319,445; 2 Claims. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

June 12, 1956

2,749,641; FALLING BLOCK SINGLE SHOT BREECH ACTION; Wilbur J. Hauck, West Arlington, Vt.; Application August 14, 1951, Serial No. 241,827; 2 Claims. (Cl. 42–23).

2,749,642; MACHINE PISTOLS; Erik Saetter-Lassen, Hellerup, Denmark; Application January 10, 1952, Serial No. 265,865; 4 Claims. (Cl. 42–75).

June 19, 1956

2,750,700; CLAMP ASSEMBLY FOR A TRIGGER HOUSING; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application May 7, 1953, Serial No. 353,700; 4 Claims. (Cl. 42–75); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,750,841; EXTRACTOR SPRING RETAINER FOR A FIREARM; Frank C. La Borde, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 24, 1953, Serial No. 344,483; 5 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,750,843; GUN FIRING SYSTEM; Robert Carlin, Milwaukee, Craig W. Cannon, Waukesha, and Joseph M. Mather, West Allis, Wis., assignors to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.; Application December 23, 1954, Serial No. 477,192; 10 Claims. (Cl. 89–27).

2,750,844; FIRE CONTROL APPARATUS; Arthur P. Davis, New York, N. Y., assignor to American Bosch Arma Corporation, a corporation of New York; Application September 1, 1936, Serial No. 98,877; 10 Claims. (Cl. 89–28).

2,750,845; BELT FEED MECHANISMS FOR AUTOMATIC FIREARMS; Bernard Maillard, Geneva, Switzerland, assignor to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of the Republic of France; Application March 25, 1952, Serial No. 278,349; Claims priority, application Luxemburg March 27, 1951; 7 Claims. (Cl. 89–33).

2,750,846; RETRACTOR; Donald P. Grover, Chicago, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application September 3, 1954, Serial No. 454,238; 8 Claims. (Cl. 89–33).

2,750,847; PNEUMATIC RECUPERATOR FOR A GUN; Victor F. Lucht, Arlington, Va., assignor to the United States of America as represented by the Secretary of the Army; Application May 17, 1951, Serial No. 226,925; 7 Claims. (Cl. 89–43); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,750,848; DOUBLE FEED PREVENTION DEVICE; Charles P. Boyer, Glenview, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application April 16, 1954, Serial No. 423,868; 3 Claims. (Cl. 89–137).

2,750,849; GAS RELIEF VALVE FOR FIREARMS; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application April 26, 1954, Serial No. 425,771; 2 Claims. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

June 26, 1956

2,751,702; CARTRIDGE FEEDING IN A TUBULAR MAGAZINE FIREARM; Lexie Ray Crittendon, Wilmington, Del., and Ellis William Hallston, Ilion, N. Y., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application January 19, 1955, Serial No. 482,726; 5 Claims. (Cl. 42–17).

2,751,819; COCKING MECHANISM FOR A SLIDE BLOCK CANNON; Owen D. Hoopes, Latham, and John B. Sillery, Albany, N. Y., assignors to the United States of America as represented by the Secretary of the Army; Application December 23, 1954, Serial No. 477,436; 6 Claims. (Cl. 89–27); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,751,820; TRIGGER AND SEAR CONTROL MECHANISM; Arthur J. Pope, Madison, Conn.; Original application June 24, 1950, Serial No. 170,178. Divided and this application May 3, 1952, Serial No. 285,839; 6 Claims. (Cl. 89–140).

July 3, 1956

2,752,714; STABILIZER FOR FIREARMS; Louis F. Landwehr, Jefferson City, Mo.; Application January 23, 1953, Serial No. 332,897; 7 Claims. (Cl. 42–75).

2,752,825; CAL. .30 MULTIPLE MACHINE GUN CARRIAGE; Herman Jackson Crigger, Lawton, Okla., and James O'Berne Millott, Lakewood, Ohio, assignors to the United States of America as represented by the Secretary of the Army; Application March 17, 1953, Serial No. 343,002; 4 Claims. (Cl. 89–37); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,752,826; CHARGING DEVICE FOR GAS OPERATED FIREARM; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 13, 1953, Serial No. 342,303; 12 Claims. (Cl. 89–191); (Granted under Title 35, U.S. Code (1952), sec. 266).

July 17, 1956

2,754,607; GAS GUN; James H. Wily, Bethlehem, Pa.; Application February 26, 1953, Serial No. 339,151; 3 Claims. (Cl. 42–55).

2,754,608; SHOCK ABSORPTION MECHANISM FOR FIREARMS; Ray H. Stieffel, Jr., Waveland, Miss.; Application January 19, 1955, Serial No. 482,789; 4 Claims. (Cl. 42–74).

2,754,725; ORDNANCE STABILIZATION SYSTEM ; Leon Le Flem, Villeneuve-la-Garenne, France, assignor to Societe Anonyme des Ateliers et Chantiers de la Loire, Paris, France; Application June 13, 1951, Serial No. 231,275; Claims priority, application France June 19, 1950; 5 Claims. (Cl. 89–37).

July 31, 1956

2,756,636; ADJUSTABLE AMMUNITION BOOSTER SPROCKETS; Charles B. Pearson, Huntington Park, Calif., assignor to Hughes Tool Company, Houston, Tex., a corporation of Delaware; Application July 18, 1950, Serial No. 174,419; 2 Claims. (Cl. 89–33).

2,756,637; CARTRIDGE MAGAZINES FOR AUTOMATIC FIREARMS; Bernard Maillard, Geneva, Switzerland, assignor to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Switzerland; Application February 1, 1952, Serial No. 269,416; Claims priority, application Luxembourg February 17, 1951; 4 Claims. (Cl. 89–33).

2,756,638; AUTOMATIC FIREARMS FED WITH CARTRIDGES BY MEANS OF FLEXIBLE BELTS, ESPECIALLY FOR USE ON AIRCRAFT; Bernard Maillard, Geneva, Switzerland, assignor to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Switzerland; Application July 3, 1952, Serial No. 297,058; Claims priority, application Luxembourg July 10, 1951; 6 Claims. (Cl. 89–33.5).

2,756,639; MULTIBARREL GUN; John R. Bird, Belmont, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application November 21, 1952, Serial No. 321,959; 13 Claims. (Cl. 89–126); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,756,640; BREECH BLOCK LOCKING MEANS; Bernard Maillard, Geneva, Switzerland, assignor to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Switzerland; Application March 30, 1951, Serial No. 218,370; Claims priority, application Luxembourg March 30, 1950; 2 Claims. (Cl. 89–187).

August 7, 1956

2,757,474; PEN TYPE TEAR GAS GUN; Don C. Williams, Huntington Park, Calif.; Application February 26, 1954, Serial No. 412,882; 5 Claims. (Cl. 42–1).

2,757,576; AMMUNITION FEED BOOSTER; James E. Chapman, Los Angeles, Calif., assignor to The Garrett Corporation, Los Angeles, Calif., a corporation of California; Application February 7, 1949, Serial No. 74,972; 14 Claims. (Cl. 89–33).

August 14, 1956

2,758,403; MAGAZINE AND CARTRIDGE CONTAINER ASSEMBLY; John L. Hill, Houston, Tex.; Original application November 4, 1949, Serial No. 125,549, now Patent No. 2,624,241, dated January 9, 1953. Divided and this application September 25, 1952, Serial No. 311,356; 3 Claims. (Cl. 42–17).

2,758,404; GUN FIRING MECHANISM; Robert Braxton Tabor, Burbank, Calif.; Application May 23, 1950, Serial No. 163,755; 1 Claims. (Cl. 42–69).

August 21, 1956

2,759,397; PROJECTILE FIRING CONTROL SYSTEM; John J. Jakosky, Los Angeles, Calif., assignor, by direct and mesne assignments, of forty per cent to International Geophysics, Inc., Los Angeles, Calif., a corporation of California, and sixty per cent to Signal Oil and Gas Company, a corporation; Application July 31, 1952, Serial No. 301,941; 6 Claims. (Cl. 89–1).

2,759,398; DUAL CONTROL FIRING MECHANISM; Albert Benditt and C. Walton Musser, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Application August 19, 1952, Serial No. 305,314; 9 Claims. (Cl. 89–27); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,759,399; FIRING MECHANISMS FOR AUTOMATIC LOADING ARMS; Miguel E. Maazo Sal, Cordoba, Argentina; Application December 1, 1952, Serial No. 323,410; 12 Claims. (Cl. 89–140).

September 4, 1956

2,761,234; TURNING BOLT LEVER ACTION RIFLE; Walter A. R. Bradley, John Day, Oreg.; Application July 28, 1953, Serial No. 370,690; 3 Claims. (Cl. 42–16).

September 11, 1956

2,762,264; SIDE-STRIPPING CARTRIDGE BELT LINK; Russell Fagerberg and Keith Miller, Rockford, Ill., assignors to the United States of America as represented by the Secretary of the Army; Application March 11, 1955, Serial No. 493,841; 2 Claims. (Cl. 89–35).

2,762,265; GUN MOUNTINGS CARRIED BY MOVABLE SUPPORTS; Arend Willem Kuijvenhoven, Barrowby, Grantham, England, assignor to Society "Brevets Aero-Mechaniques," S. A., Geneva, Switzerland, a society of Switzerland; Application July 24, 1950, Serial No. 175-589; 3 Claims. (Cl. 89–41).

2,762,267; SAFETY DEVICE FOR AUTOMATIC WEAPONS; Janne Olof Persson, Karlskoga, and Knut Roland Palmqvist, Bofors, Sweden, assignors to Aktiebolaget Bofors, Bofors, Sweden; Application February 8, 1952, Serial No. 270,676; Claims priority, application Sweden March 5, 1951; 8 Claims. (Cl. 89–135).

September 18, 1956

2,763,081; GUN BARREL SEALING DEVICE; John M. Huckabee, Shreveport, La.; Application November 3, 1953, Serial No. 389,964; 3 Claims. (Cl. 42–1).

2,763,190; GUN MOUNTING; Earl E. Libman, Brooklyn, N. Y., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Application October 15, 1953, Serial No. 386,415; 10 Claims. (Cl. 89–42).

September 25, 1956

2,763,951; BUTT PLATE LOCK MEANS; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of Army; Application February 4, 1953, Serial No. 335,177; 1 Claim. (Cl. 42–71); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 2, 1956

2,764,914; APPARATUS FOR COOLING GUN BARRELS; John P. Young, Johnson, Vt., assignor to the United States of America as represented by the Secretary of Commerce; Application October 10, 1947, Serial No. 779,089; 4 Claims. (Cl. 89–14.1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,764,915; DIRECTIONAL GUN MOUNTING; Will Weiss, Vernier, near Geneva, Switzerland, assignor to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of France; Application July 1, 1952, Serial No. 296,692; Claims priority, application Great Britain July 11, 1951; 4 Claims. (Cl. 89–41).

2,764,916; ARTILLERY INSTALLATIONS FOR FIRING ON MOVING TARGETS; Bernard Maillard and Leonard Ambrosini, Geneva, Switzerland, assignors to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Confederation of Switzerland; Application July 24, 1952, Serial No. 300,594; Claims priority, application Luxembourg July 30, 1951; 4 Claims. (Cl. 89–41).

October 9, 1956

2,765,557; CARRIER LATCH CONSTRUCTION FOR REPEATING FIREARMS; Walter F. Roper, Longmeadow, Mass., assignor to Savage Arms Corporation, Utica, N. Y., a corporation of Delaware; Application August 25, 1953, Serial No. 376,450; 13 Claims. (Cl. 42–17).

2,765,558; CARTRIDGE MAGAZINE AND LATCH CONSTRUCTION FOR REPEATING FIREARMS; Walter F. Roper, Longmeadow, and Frederick J. Wright, Springfield, Mass., assignors to Savage Arms Corporation, Utica, N. Y., a corporation of Delaware; Application August 25, 1953, Serial No. 376,346; 2 Claims. (Cl. 42–18).

2,765,559; CARRIER MECHANISM FOR GUNS; William B. Morris, Fort Worth, Tex.; Application August 28, 1952, Serial No. 306,809; 1 Claim. (Cl. 42–23).

2,765,560; CARTRIDGE CASE EJECTION DEVICE FOR AUTOMATIC FIREARMS; Friedrich Linder, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Application October 3, 1950, Serial No. 188,170; 1 Claim. (Cl. 42–25).

2,765,561; REPEATING RIFLE HAVING TRIGGER MECHANISM ON FINGER LEVER; William B. Morris, Fort Worth, Tex.; Application December 17, 1951, Serial No. 261,984; 3 Claims. (Cl. 42–69).

2,765,562; TRIGGER MECHANISM FOR BOLT ACTION FIREARMS; Walter F. Roper, Longmeadow, and Frederick J. Wright, Springfield, Mass., assignors to Savage Arms Corporation, Utica, N. Y., a corporation of Delaware; Application February 20, 1953, Serial No. 338,048; 1 Claim. (Cl. 42–69).

2,765,563; RECEIVER RECOIL PLATE CONSTRUCTION FOR SHOTGUNS AND THE LIKE; Walter F. Roper, Longmeadow, and Frederick J. Wright, Springfield, Mass., assignors to Savage Arms Corporation, Utica, N. Y., a corporation of Delaware; Application January 22, 1953, Serial No. 332,632; 1 Claim. (Cl. 42–75).

2,765,564; AUTOMATIC SHOTGUN CHOKE OPERATED BY GASES OF EXPLOSION; Ario E. Schroeder, Newton, Kans.; assignor, by mesne assignments, to Jarvis Manufacturing, Inc., Wichita, Kans., a corporation of Kansas; Application December 23, 1953, Serial No. 399,914; 9 Claims. (Cl. 42–79).

2,765,706; MUZZLE BRAKE; Kenneth C. Strohl, Fairmont, Minn.; Application March 6, 1953, Serial No. 340,701; 9 Claims. (Cl. 89–14).

2,765,708; GUN RECOIL MECHANISM; Arnold Raines, Philadelphia, Pa.; Original application March 25, 1949, Serial No. 83,360, now Patent No. 2,669,325, dated February 16, 1954. Divided and this application April 17, 1953, Serial No. 349,339; 1 Claim. (Cl. 89–43).

2,765,709; TRIGGER MECHANISM FOR AUTOMATIC FIREARMS; Erwin Hopperlo and Ernst Mublemann, Zurich, Switzerland, assignors to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Application May 27, 1950, Serial No. 164,724; 5 Claims. (Cl. 89–137).

2,765,710; BREECH BLOCK CONTROLLING MECHANISM FOR A RETARDED BLOW BACK GUN; Earl H. Bradley, Seekonk, Mass.; Application December 27, 1952, Serial No. 328,244; 12 Claims. (Cl. 89–195).

October 16, 1956

2,766,542; BUTT PLATE ASSEMBLY; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application February 19, 1953, Serial No. 337,897; 3 Claims. (Cl. 42–71); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,766,661; BORE EVACUATOR WITH ELASTIC ACTION; Waldo Margulis, Albany, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Application October 9, 1953, Serial No. 385,306; 6 Claims. (Cl. 89–1); (Granted under Title 35, U. S. Code (1952), sec. 266).

2,766,663; FEED MECHANISM; Paul H. Dixon, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application August 15, 1952, Serial No. 304,482; 19 Claims. (Cl. 89–33).

October 23, 1956

2,767,615; RELOADER AND MAGNETIC BRAKE FOR AUTOMATIC MACHINE GUN; Albert L. Hardy, Schenectady, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Application February 14, 1952, Serial No. 271,552; 5 Claims. (Cl. 89–1).

2,767,617; CARTRIDGE CASE EJECTION MECHANISM; Clarence P. Taylor, Manhattan Beach, Calif., assignor to North American Aviation, Inc.; Application December 11, 1951, Serial No. 261,115; 4 Claims. (Cl. 89–33).

2,767,618; TRIPOD FOR A GUN; Raffaello Nistri, Rome, Italy; Application January 29, 1953, Serial No. 333,944; Claims priority, application Italy May 30, 1952; 2 Claims. (Cl. 89–40).

October 30, 1956

2,768,461; COMBINED EXTRACTOR AND TELESCOPE CAM PLATE; Leslie E. Whittemore and Russell M. Smith, Dorchester, Mass.; Application August 5, 1953, Serial No. 372,572; 3 Claims. (Cl. 42–25).

November 13, 1956

2,770,169; **DEPTH-CHARGE LAUNCHER**; Sven Gummar Gerdin, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish corporation; Application May 27, 1952, Serial No. 290,448; Claims priority, application Sweden November 5, 1951; 4 Claims. (Cl. 89–1).

2,770,170; **HOIST FOR PROJECTILES**; Erik Albin Franson, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish corporation; Application May 28, 1952, Serial No. 290,449; Claims priority, application Sweden November 5, 1951; 5 Claims. (Cl. 89–46).

November 20, 1956

2,770,904; **GRENADE LAUNCHING DEVICE FOR A FIREARM HAVING A MUZZLE BRAKE**; Will Welss, Vernier par Geneva, Switzerland, assignor to Brevets Aero-Mecaniques, S. A., Geneva, Switzerland, a society of Switzerland; Application October 22, 1951, Serial No. 252,462; Claims priority, application Luxemburg October 24, 1950; 1 Claim. (Cl. 42–1).

November 27, 1956

2,771,697; **REMOVABLE HANDGRIP FOR GUNS**; Harry A. Reising, La Grange, Ill.; Application August 10, 1953, Serial No. 373,132; 2 Claims. (Cl. 42–71).

2,771,698; **AUTOMATIC CHOKE FOR SHOT GUNS**; William T. Rochelle, Atlanta, Ga.; Application December 4, 1953, Serial No. 396,155; 4 Claims. (Cl. 42–79).

2,771,819; **GAS-OPERATING FIREARM**; Charles H. Morse, Herkimer, and Homer W. Young, Ilion, N. Y., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application October 12, 1953, Serial No. 385,428; 6 Claims. (Cl. 89–191).

December 11, 1956

2,773,325; **MAGAZINE AND CARTRIDGE CONTAINER ASSEMBLY**; John L. Hill, Houston, Tex.; Application June 26, 1953, Serial No. 364,301; 7 Claims. (Cl. 42–50).

2,773,424; **GUN PERFORATOR**; Thomas A. Andrew, Pasadena, Calif., assignor of one-fourth to Mordica O. Johnston, one-eighth to Mordica O. Johnston, Jr., and one-eighth to Warren C. Johnston, all of Glendale, Calif.; Application June 1, 1951, Serial No. 229,506; 13 Claims. (Cl. 89–1).

2,773,425; **GUN RELOADER**; Walter R. Weeks, Hamden, Conn., assignor to General Electric Company, a corporation of New York; Application July 19, 1945, Serial No. 605,971; 10 Claims. (Cl. 89–1).

December 18, 1956

2,774,281; **INJECTOR PUMP FOR BREECH COOLING OF GUNS**; George A. Hawkins, West Lafayette, Ind., assignor to Purdue University, Lafayette, Ind.; Application September 19, 1945, Serial No. 617,374; 2 Claims. (Cl. 89–1).

2,774,283; **BREECH MECHANISM FOR A FIREARM**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 14, 1954, Serial No. 436,749; 1 Claim. (Cl. 89–194); (Granted under Title 35, U.S. Code (1952), sec. 266).

December 25, 1956

2,775,051; **SAFETY FOR FIREARMS**; George Gehman, Oxford, N. J.; Application October 23, 1953, Serial No. 387,914; 2 Claims. (Cl. 42–70).

2,775,052; **BIPOD AND FACE SHIELD FOR A RIFLE**; C. Walton Musser and Francis W. Dietach, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Application November 21, 1952, Serial No. 321,961; 9 Claims. (Cl. 42–94); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,775,164; **GUN BARREL**; Folke Gustav Tillander and Ivan Aslund, Bofors, Sweden, assignors to Aktiebolaget Bofors, Bofors, Sweden, a Swedish corporation; Application December 27, 1952, Serial No. 328,162; Claims priority, application Sweden February 11, 1952; 10 Claims. (Cl. 89–16).

2,775,165; **FIRING MECHANISM**; John L. Lochhead, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 3, 1954, Serial No. 434,350; 2 Claims. (Cl. 89–139); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,775,166; **PIVOTED BREECH BOLT LOCK FOR GAS PISTON FIREARMS**; Stefan K. Janson, London, England, assignor to the Minister of Supply in Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, London, England; Application August 22, 1952, Serial No. 305,805; Claims priority, application Great Britain August 22, 1951; 2 Claims. (Cl. 89–191).

January 1, 1957

2,775,835; **BOLT MECHANISM FOR FIREARM**; Alonzo F. Gaidos, Redwood City, Calif.; Original application February 1, 1950, Serial No. 141,801. Divided and this application December 8, 1952, Serial No. 324,855; 2 Claims. (Cl. 42–16); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,775,836; **SPEED TRIGGER**; Roy J. Emerson, Superior, Wis.; Application February 5, 1954, Serial No. 408, 496; 1 Claim. (Cl. 42–69).

2,775,837; **FIRING MECHANISM FOR A FIREARM**; Claude Alfred Perry, Olton, and Roger David Wackrow, Handsworth, England, assignors to The Birmingham Small Arms Company Limited, Birmingham, England, a British company; Application October 16, 1952, Serial No. 315,012; Claims priority, application Great Britain August 26, 1952; 5 Claims. (Cl. 42–69).

2,775,920; **BOLT SPLINE**; Paul H. Dixon and Maynard B. Wallin, Rockford, Ill., assignors to the United States of America as represented by the Secretary of the Army; Application May 1, 1950, Serial No. 159,336; 4 Claims. (Cl. 89–188).

January 8, 1957

2,776,513; **LEVER ACTION FIREARM**; Ernest C. Neal, Chicago, Ill., assignor of one-half to Elmer Brandell, Chicago, Ill.; Original application July 25, 1951, Serial No. 238,417. Divided and this application August 20, 1952, Serial No. 305,429; 12 Claims. (Cl. 42–16).

2,776,599; **JAM-PROOF GUN AMMUNITION FEED CAN**; Raymond A. Starry, Holicong, Pa., assignor to the United States of America as represented by the Secretary of the Navy; Application August 31, 1953, Serial No. 377,744; 2 Claims. (Cl. 89–34); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,776,600; **SEAR DEVICE FOR AN AUTOMATIC FIREARM**; Edward C. Lee, Detroit, Mich., assignor to the United States of America as represented by the Secretary of the Army; Application December 31, 1953, Serial No. 401,741; 3 Claims. (Cl. 89–136).

2,776,601; **SEAR DEVICE FOR AN AUTOMATIC FIREARM**; Edward C. Lee, Detroit, Mich., assignor to the United States of America as represented by the Secretary of the Army; Application November 25, 1953, Serial No. 394,524; 4 Claims. (Cl. 89–136).

2,776,602; **BARREL POSITIONING MEANS FOR AUTOMATIC PISTOL**; Foster E. Sturtevant, West Hartford, Conn., assignor, by mesne assignments, to Colt's Patent Fire Arms Manufacturing Company, Incorporated, Hartford, Conn., a corporation of Delaware; Application September 25, 1953, Serial No. 382,295; 9 Claims. (Cl. 89–196).

January 15, 1957

2,777,234; **LEVER ACTION FIREARM**; Ernest C. Neal, Chicago, Ill., assignor of one-half to Elmer Brandell, Chicago, Ill.; Continuation of application Serial No. 238,417, July 25, 1951. This application April 19, 1955, Serial No. 502,485; 14 Claims. (Cl. 42–16).

2,777,235; **FIREARM MAGAZINE WITH NEGATOR COIL SPRINGS**; Edward W. Hopkins, Longmeadow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 10, 1953, Serial No. 341,625; 2 Claims. (Cl. 42–50); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,777,236; **LINK EXTRACTOR FOR REVOLVER TYPE AUTOMATIC GUN**; Walter F. Runge, Elmhurst, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application January 19, 1954, Serial No. 405,060; 2 Claims. (Cl. 42–68).

2,777,237; **EXTRACTOR FOR REVOLVER TYPE AUTOMATIC GUN**; William P. Murphy, West Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 19, 1954, Serial No. 405,053; 1 Claim. (Cl. 42–68); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,777,365; **AUTOMATIC FIREARM**; Daniel D. Musgrave, Cabin John Park, Md.; Application April 13, 1954, Serial No. 422,756; 17 Claims. (Cl. 89–155).

2,777,366; **GAS SYSTEM FOR FIREARMS**; Loren C. Cook, Rodeo, Calif.; Application April 22, 1953, Serial No. 350,541; 4 Claims. (Cl. 89–191); (Granted under Title 35, U.S. Code (1952), sec. 266).

January 22, 1957

2,778,137; **GRENADE LAUNCHER**; Edgar William Brandt, Geneva, Switzerland, assignor to Societe Anonyme Belge de Macanique et d'Armement, Brussels, Belgium, a corporation of Belgium; Application August 7, 1953, Serial No. 372,950; Claims priority, application Luxemburg, September 15, 1952; 2 Claims. (Cl. 42–1).

2,778,276; **MECHANISM ON AUTOMATIC FIREARMS WITH REVOLVER DRUMS**; Erwin Hepperle, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Application March 22, 1951, Serial No. 216,885; 2 Claims. (Cl. 89–33).

2,778,277; **SIGHT MOUNTING FOR A GUN WITH A CRADLE MOUNT**; Heinrich Herlach, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a Swiss company; Application May 2, 1952, Serial No. 285,726; 4 Claims. (Cl. 89–41).

2,778,278; **GUN-CARRIAGE WITH MUZZLE BRAKE**; Heinrich Herlach and Oskar Schwager, Zurich, Switzerland, assignors to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company organized under Swiss laws; Application April 12, 1952, Serial No. 281,952; 5 Claims. (Cl. 89–42).

2,778,279; **LOADING MECHANISM**; Alexander D. F. Moncrieff, Detroit, Mich., assignor to Michigan Tool Company, Detroit, Mich., a corporation of Delaware; Original application October 1, 1948, Serial No. 52,388, now Patent No. 2,693,133, dated November 2, 1954. Divided and this application February 1, 1954, Serial No. 411,673; 1 Claim. (Cl. 90–1.6).

January 29, 1957

2,779,241; **ELASTIC ACTION CANNON BORE SCAVENGER**; Willington R. Howard, Falls Church, Va., and Waldo Margulis, Albany, N. Y., assignors to the United States of America as represented by the Secretary of the Army; Application June 18, 1954, Serial No. 437,894; 11 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,779,242; **BREECH MECHANISMS**; Augustus D. Willhauck, Melrose, Mass., assignor to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey; Application April 4, 1952, Serial No. 280,468; 10 Claims. (Cl. 89–24).

2,779,243; **APPARATUS TO REMOVE EJECTED SHELLS FROM TURRET**; Desmond W. Molins, Frederick Pocock, and Sidney R. Hopkins, Deptford, London, England; Application October 1, 1951, Serial No. 249,048; Claims priority, application Great Britain October 5, 1950; 15 Claims. (Cl. 89–33).

2,779,245; **PROJECTILE PARBUCKLING MECHANISM**; George L. Smith, Washington, D. C.; Application August 4, 1950, Serial No. 177,748; 13 Claims. (Cl. 89–45); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,779,246; **HYDRAULIC RAMMER CONTROL AND DRIVE SYSTEM**; David Wertman, Kensington, Md., and Frank Warlick, Washington, D.C.; Application June 28, 1954, Serial No. 439,939; 5 Claims. (Cl. 89–47); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,779,247; **SEAR MECHANISM FOR A FIREARM**; Harry E. Pinkerton, Jr., Oyster Bay, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Application September 28, 1954, Serial No. 459,001; 6 Claims. (Cl. 89–135).

2,779,248; **CAM BLOCK ACTUATOR**; Charles H. Stevens, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application August 28, 1953, Serial No. 377,268; 6 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,779,249; **RETURN-AND BUFFER MECHANISM FOR AUTOMATIC SHOOTING WEAPONS**; Erik Saetter-Lassen, Hellerup, near Copenhagen, Denmark; Application October 16, 1953, Serial No. 386,639; 7 Claims. (Cl. 89–198).

2,779,250; **AUTOMATIC CONTROL MECHANISM**; Fred A. Hassman, Cincinnati, Ohio, assignor to The Cincinnati Milling Machine Co., Cincinnati, Ohio, a corporation of Ohio; Application July 11, 1952, Serial No. 298,303; 6 Claims. (Cl. 90–21).

February 5, 1957

2,780,019; **GUN BARREL OF ALUMINUM ALLOY WITH METALLIC COATINGS**; George C. Sullivan, Hollywood, Calif.; Application February 19, 1952, Serial No. 272,428; 4 Claims. (Cl. 42–76).

2,780,145; **BREECH BLOCK RETURN MEANS**; Dieudonne Joseph Saive, Wandre, Belgium, assignor to Fabrique Nationale d'Armes de Guerre, Herstal, Belgium, a Belgian society; Application March 30, 1953, Serial No. 345,277; Claims priority, application Belgium April 7, 1952; 2 Claims. (Cl. 89–199).

February 12, 1957

2,780,881; **FIREARM EJECTOR**; Lexie R. Crittendon, Wilmington, Del., and Philip R. Haskell, Fairfield, Conn., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Original application January 31, 1950, Serial No. 141,532. Divided and this application December 19, 1952, Serial No. 327,008; 1 Claim. (Cl. 42–25).

2,780,882; **ELECTRICALLY POWERED FIRE CONTROL MECHANISM FOR FIREARMS**; Lemuel M. Temple, North Haven, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application November 16, 1953, Serial No. 392,303; 12 Claims. (Cl. 42–84).

2,780,962; **BLAST SUPPRESSOR**; Murray Ressler, Silver Spring, Md., and Howard S. Halpern, Washington, D. C., assignors to the United States of America as represented by the Secretary of the Navy; Application March 23, 1953, Serial No. 344,251; 4 Claims. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,780,963; **CARTRIDGE BELT LINK AND STRENGTH MEMBER THEREFOR**; Paul H. Dixon, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application March 17, 1955, Serial No. 495,072; 4 Claims. (Cl. 89–35).

2,780,965; **FIRE CONTROL MECHANISM**; William R. Kunz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application October 14, 1954, Serial No. 462,405; 6 Claims. (Cl. 89–154); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 19, 1957

2,781,696; **AUTOMATIC AMMUNITION LOADING DEVICE**; James G. Shonts, Palo Alto, and Samuel H. Stephenson, Mountain View, Calif., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Application January 13, 1949, Serial No. 70,686; 8 Claims. (Cl. 89–45).

February 26, 1957

2,782,688; **MACHINE GUN**; Wayne E. Leek, Ilion, Charles H. Morse, Herkimer, and Charles C. Webb, Mohawk, N. Y., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application January 11, 1954, Serial No. 403,278; 7 Claims. (Cl. 89–199).

March 5, 1957

2,783,569; **GUN SAFETY MECHANISM**; Eric Claesson, Huskvarna, Sweden, assignor to Husqvarna Vapenfabriks Aktiebolag, Huskvarna, Sweden, a corporation of Sweden; Application March 6, 1953, Serial No. 340,757; 3 Claims. (Cl. 42–41).

2,783,570; **MAGAZINE CHARGER FOR FIREARMS**; William R. Kunz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application April 29, 1954, Serial No. 426,613; 1 Claim. (Cl. 42–87); (Granted under Title 35, U.S. Code (1952, sec. 266).

2,783,685; **REGULATING PLUG FOR GAS OPERATED FIREARM**; Samuel G. Green, Gray, Ga.; Application March 2, 1951, Serial No. 213,640; 2 Claims. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

March 19, 1957

2,785,492; **LEVER-OPERATED RIFLE WITH INTEGRAL BREECH-BOLT AND MAGAZINE**; Wilfred I. Smith, Chicopee Falls, Mass., assignor to Noble Manufacturing Co., Inc., Haydenville, Mass., a corporation of Massachusetts; Application December 20, 1954, Serial No. 476,145; 1 Claim. (Cl. 42–17).

2,785,605; **FIRING MECHANISM FOR AUTOMATIC RIFLES**; Marc Jourdat, St.-Etienne, France, assignor to Societe a responsibilie limitee Gevarm, Saint-Etienne (Loire), France, a French corporation; Application April 11, 1952, Serial No. 281,746; Claims priority, application France April 17, 1951; 3 Claims. (Cl. 89–140).

2,785,606; **PNEUMATIC GUN MOUNT**; Charles D. Bock, Floral Park, and Earle P. Blanchard, New York, N. Y., assignors to American Bosch Arms Corporation, a corporation of New York; Application April 19, 1954, Serial No. 423,929; 9 Claims. (Cl. 89–43).

2,785,607; **LOADING DEVICE FOR A GUN WITH A BARREL MOUNTED FOR TRAVERSING AND ELEVATING OR DEPRESSING**; Sten August Henstrom, Bofors, and Alf Alvar Hampus Johnson, Kariskoga, Sweden, assignors to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Application November 17, 1953, Serial No. 392,684; Claims priority, application Sweden November 24, 1952; 13 Claims. (Cl. 89–45).

March 26, 1957

2,786,293; **ROTATABLY MOUNTED SEAR SAFETY**; Loren C. Cook, Rodeo, Calif.; Application April 22, 1953, Serial No. 350,542; 1 Claim. (Cl. 42–70); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,786,394; **POSITIVE ACTION CAM TRACK FOR AUTOMATIC GUNS WITH ROTATABLE CARTRIDGE DRUM**; Eugene S. Wassel, Cleero, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application December 17, 1954, Serial No. 476,097; 5 Claims. (Cl. 89–155).

April 2, 1957

2,787,192; **SEMI-AUTOMATIC REPEATING ROCKET LAUNCHER**; Stephen A. Stam, Glendale, Calif., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application October 5, 1953, Serial No. 384,360; 9 Claims. (Cl. 89–1.7).

2,787,193; **TRIGGER DEVICE ON GUN MOUNTS**; Heinrich Herlach, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a Swiss company; Application July 3, 1952, Serial No. 297,130; 4 Claims. (Cl. 89–27).

2,787,194; **GUN INSTALLATION IN JET AIRCRAFT**; Paul F. Peterson, Palos Verdes Estates, Calif., assignor to North American Aviation, Inc.; Application February 24, 1955, Serial No. 490,216; 10 Claims. (Cl. 89–37.5).

April 9, 1957

2,787,855; **ADJUSTABLE RIFLE BUTT PLATE**; Alonzo F. Guymon, Downey, Calif.; Application October 26, 1953, Serial No. 388,367; 1 Claim. (Cl. 42–73).

April 16, 1957

2,788,599; **SIGHTING DEVICE**; Edgar William Brandt, Geneva, Switzerland, assignor to Anstalt fur die Entwicklung von Erfindungen und Gewerblichen Anwendungen "Energa," Vaduz, Liechtenstein, a corporation of Liechtenstein; Application October 30, 1951, Serial No. 253,799; 2 Claims. (Cl. 42–1).

2,788,600; **GUN-SIGHT MECHANISM**; James Pokorny, Grants Pass, Oreg.; Application May 27, 1955, Serial No. 511,668; 9 Claims. (Cl. 42–1).

2,788,601; **TRIGGER MECHANISM**; Earl L. Hardgrave, Austin, Tex.; Application December 12, 1955, Serial No. 552,452; 10 Claims. (Cl. 42–69).

2,788,714; **RECOIL MECHANISM FOR FIREARMS**; Val A. Browning, Ogden, Utah, assignor to Browning Industries, Inc., Ogden, Utah, a corporation of Utah; Application July 18, 1955, Serial No. 522,679; 2 Claims. (Cl. 89–177).

2,788,715; **AUTOMATIC LOADING FIREARMS HAVING A BREECH BLOCK TEMPORARILY HELD IN LOCKED POSITION BY A SLIDING SYSTEM**; Marc Birkigt, Versoix, near Geneva, Switzerland, assignor to "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Switzerland; Application February 9, 1951, Serial No. 210,105; Claims priority, application Luxemburg February 18, 1950; 1 Claim. (Cl. 89–190).

April 23, 1957

2,789,466; **MANUAL GUN CHARGER**; Stanley E. Summers, Los Angeles, Calif., assignor to the United States of America as represented by the Secretary of the Army; Application March 6, 1953, Serial No. 340,941; 2 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,789,470; PROJECTILE FEED DEVICE; George A. Bronson, Santa Monica, Calif., assignor to Douglas Aircraft Company, Inc., Santa Monica, Calif.; Application August 5, 1952, Serial No. 302,779; 13 Claims. (Cl. 89—1.7).

2,789,471; LIGHTWEIGHT RECOILLESS ARTILLERY WEAPON; Gulon S. Bluford, Philadelphia, and Clarence Walton Musser, Glenside, Pa., assignors to the United States of America as represented by the Secretary of War; Application February 7, 1951, Serial No. 209,892; 3 Claims. (Cl. 89—1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,789,472; HYDRAULIC BREECH CONTROL SYSTEM; Frank Warlick, Washington, D. C.; Application June 28, 1954, Serial No. 439,938; 4 Claims. (Cl. 89—4); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,789,473; FIRING PIN SAFETY DEVICE FOR BREECH MECHANISMS; James M. Edmund, Montgomery County, Md., assignor to the United States of America as represented by the Secretary of the Navy; Application October 29, 1954, Serial No. 465,763; 6 Claims. (Cl. 89—27).

2,789,474; MEANS FOR STRIPPING LINKS IN A FIREARM; Burns Darsel, Watertown, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application November 19, 1951, Serial No. 256,989; 4 Claims. (Cl. 89—33).

2,789,475; GUN FIRE CONTROL SYSTEM WITH HYDRAULIC SUPERELEVATION; Russell E. Bauer, Grosse Pointe Woods, and John D. Lorimer, Birmingham, Mich.; Application February 25, 1955, Serial No. 490,550; 3 Claims. (Cl. 89—41).

2,789,476; ELEVATING MECHANISM FOR A MOBILE GUN; Paul Jean Marie Rene Delalande, Washington, D. C., assignor to Anstalt fur die Entwicklung von Erfindungen and Gewerblichen Andwendungen Energa, Vaduz, Liechtenstein; Application April 11, 1955, Serial No. 500,437; Claims priority, application Switzerland May 4, 1954; 1 Claim. (Cl. 89—41).

2,789,477; TRIGGER DEVICE ON MULTIPLE-GUN MOUNTS FOR AUTOMATIC GUNS; Heinrich Herlach, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Application August 1, 1952, Serial No. 302,055; Claims priority, application Switzerland August 8, 1951; 5 Claims. (Cl. 89—127).

2,789,479; BOLT LOCK AND RETRACTING MECHANISM FOR GAS OPERATED MACHINE GUN; Alexander Stone McColl, Kalamazoo, Mich.; Application November 8, 1952, Serial No. 319,554; 3 Claims. (Cl. 89—191).

April 30, 1957

2,790,261; SAFETY CONTROL DEVICE FOR A RIFLE WITH A SCOPE; McEathron W. Wood, Charleston, W. Va.; Application May 26, 1953, Serial No. 357,431; 1 Claim. (Cl. 42—70).

2,790,262; ADJUSTABLE GUNSTOCK; Earnest N. Baker, Kansas City, Mo., assignor to Fred D. Baker, Buckner, Mo.; Application September 29, 1952, Serial No. 312,115; 3 Claims. (Cl. 42—73).

2,790,351; GUN CHARGER; Guy Webb, Jr., Hyattsville, and Donald F. Romer, Greenbelt, Md.; Application January 6, 1955, Serial No. 480,310; 2 Claims. (Cl. 89—1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,790,353; FEEDING MECHANISM FOR A FIREARM; John R. Bird, Belmont, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application November 29, 1951, Serial No. 258,975; 9 Claims. (Cl. 89—1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,790,354; MASS ACCELERATOR; Yusuf A. Yoler, Schenectady, and James D. Cobine, Redford, N. Y., assignors to General Electric Company, a corporation of New York; Application April 20, 1956, Serial No. 579,682; 8 Claims. (Cl. 89—8).

2,790,355; CARTRIDGE ALIGNING MEANS FOR A FIREARM; Roy S. Sanford, Woodbury, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application November 16, 1951, Serial No. 256,722; 4 Claims. (Cl. 89—33).

2,790,356; FEEDING MECHANISM FOR A GUN INCLUDING A RAMMING CHAMBER; Sven Gunnar Gerdin, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Application November 18, 1952, Serial No. 321,237; Claims priority, application Sweden November 30, 1951; 12 Claims. (Cl. 89—33).

2,790,357; RECOIL MECHANISM FOR A MORTAR; Emil Garrett, Mauk, Ga.; Application September 16, 1952, Serial No. 309,959; 1 Claim. (Cl. 89—43); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,790,358; PROJECTILE BUFFER; Frank Warlick, Washington, D. C.; Application September 28, 1950, Serial No. 187,340; 1 Claim. (Cl. 89—45); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 7, 1957

2,791,053; SELECTIVE TRIGGER OPERATING MECHANISM FOR A DOUBLE BARREL SHOTGUN; Walter M. Fay, Ludlow, Mass.; Application May 10, 1956, Serial No. 584,027; 2 Claims. (Cl. 42–42).

2,791,155; **RECOIL REDUCING DEVICE FOR FIREARMS**; Ralph Thiel, Seaside, Calif.; Application October 16, 1952, Serial No. 315,027; 2 Claims. (Cl. 89–14).

2,791,156; **MOVING MECHANISM FOR A POWER-LAID WEAPON**; Sten August Henstrom, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Application November 18, 1953, Serial No. 392,796; Claims priority, application Sweden January 24, 1953; 4 Claims. (Cl. 89–41).

May 14, 1957

2,791,855; **SHELL CARRIER MECHANISM FOR AUTOMATIC SHOTGUNS**; Ernest P. Simmons, Kansas City, Kans., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application October 7, 1954, Serial No. 460,906; 5 Claims. (Cl. 42–17).

2,791,856; **FIREARM WITH SINTERED METAL CHAMBER**; James C. Hartley, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application January 6, 1954, Serial No. 402,561; 5 Claims. (Cl. 42–76).

2,791,940; **DEVICE FOR PURGING GUNS**; Sumpter M. Speake, Royal Oak, and Wilfred E. Mazur, Detroit, Mich., assignors to the United States of America as represented by the Secretary of the Army; Application April 28, 1948, Serial No. 23,742; 15 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,791,942; **RATE DEDUCER FOR A FIREARM**; David C. Fletcher, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 8, 1954, Serial No. 403,080; 4 Claims. (Cl. 89–131); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,791,943; **ACTUATOR SWITCH FOR REVOLVER-TYPE AUTOMATIC GUN**; Otto H. von Lossnitzer, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 5, 1954, Serial No. 414,522; 4 Claims. (Cl. 89–156); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,791,944; **GAS REGULATOR FOR A FIREARM**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application April 7, 1954, Serial No. 421,717; 4 Claims. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,791,945; **RECOIL ADAPTER**; Karl W. Maier, Torrance, Calif., assignor to the United States of America as represented by the Secretary of the Army; Application November 6, 1953, Serial No. 390,765; 3 Claims. (Cl. 89–198); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 21, 1957

2,792,657; **GUN BARREL COATED WITH TANTALUM**; Edward E. Slowter, Columbus, Ohio, assignor, by mesne assignments, to Battelle Development Corporation, Columbus, Ohio, a corporation of Delaware; Application May 16, 1946, Serial No. 670,132; 2 Claims. (Cl. 42–76).

2,792,758; **REACTION DEVICE**; John H. Bach and Vaughn E. Peak; Hawthorne; and Karl W. Maier; Torrance, Calif.; a corporation of California; Application November 8, 1954; Serial No. 467,332; 15 Claims. (Cl. 89–1.7).

2,792,759; **PROJECTILE FUZE SETTING APPARATUS**; Ernest F. Campbell, Springfield, Va.; Phillas H. Girouard, Washington, D.C.; and Alvin E. Cohen, Chicago, Ill.; Application December 13, 1951; Serial No. 261,572; 2 Claims. (Cl. 89–6); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,792,760; **COMBINATION FLASH ELIMINATOR AND STABILIZER FOR A FIREARM**; Alexander Hammer, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application March 6, 1954; Serial No. 419,117; 6 Claims. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,792,761; **GUN FEEDING MECHANISM**; Clarence E. Simpson; Wilbraham, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application October 29, 1952; Serial No. 317,605; 6 Claims. (Cl 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,792,762; **FEED AND STOP PAWL DEPRESSOR ARRANGEMENT FOR A GUN**; Franklin E. Niess; Washington, D.C.; Application January 20, 1954; Serial No. 405,265; 7 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 28, 1957

2,793,455; **FIRING PIN FOR FIREARMS**; Melvin C. Wignall; Elko, Nev.; Application December 6, 1954; Serial No. 473,086; 1 Claim; (Cl. 42–69)

2,793,567; **SIDE EJECTION ARRANGEMENT**; Ewald A. Kamp; Chicago, Ill.; assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application December 7, 1954; Serial No. 473,768; 2 Claims.; (Cl. 89–33).

June 4, 1957

2,794,285; **FIREARM SAFETY**; Ralph E. Clarkson; Hamden, Conn.; assignor to Olin Mathieson Chemical Corporation; New Haven, Conn.; a corporation of Virginia; Application November 24, 1954; Serial No. 470,901; 22 Claims; (Cl. 42–17).

2,794,369; **SIDE-STRIPPING CARTRIDGE BELT LINK**; Burns Darsie, Rockford, Ill.; assignor to the United States of America as represented by the Secretary of the Army; Application December 14, 1954; Serial No. 475,320; 8 Claims; (Cl. 89–35).

June 11, 1957

2,795,171; **BREECH MECHANISM FOR A RIFLE**; Alonzo F. Gaidos; Redwood City, Calif.; Original application February 1, 1950; Serial No. 141,801; Divided and this application December 8, 1952; Serial No. 324,856; 2 Claims.; (Cl. 89–187); (Granted under Title 35, U.S. Code (1952), sec. 266).

June 18, 1957

2,795,880; **CARTRIDGE MAGAZINE WITH SPRING GUIDE MEANS**; George William Patchett; Gidea Park, England; Application April 21, 1953; Serial No. 350,081; 4 Claims; (Cl. 42–50).

2,795,881; **GUN RECEIVER REINFORCING SLEEVE**; Orren W. Bellows; Wilcox, Pa.; Application February 9, 1956; Serial No. 564,500; 1 Claim; (Cl. 42–75).

2,796,004; **COCKING MECHANISMS FOR AUTOMATIC GUNS**; Henry William Trevaskis, Solihull; and Douglas Dewar, Wolston, near Coventry, England; assignors to Dunlop Rubber Company Limited; London, England; a British company; Application November 2, 1953; Serial No. 389,823; 11 Claims; (Cl. 89–1)

2,796,005; **RIFLE CONTROL TUBE**; Alfred F. Shapel; Boise, Idaho; Application June 7, 1954; Serial No. 434,966; 1 Claim; (Cl. 89–14).

July 2, 1957

2,797,515; **MEANS FOR THE TAKE-DOWN OF A FIREARM**; Harry L. Pagett; Ithaca, N.Y.; assignor to Ithaca Gun Company, Incorporated; Application April 16, 1954; Serial No. 423,648; 13 Claims; (Cl. 42–75).

2,797,622; **REGULATING MECHANISM TO CONTROL THE FEEDING OF CARTRIDGES IN BELT-FED MACHINE GUNS**; Eric Saetter-Lassen; Gentofte, Denmark; Application November 6, 1952; Serial No. 319,061; Claims priority, application Denmark November 17, 1951; 5 Claims; (Cl. 89–33).

July 9, 1957

2,798,412; **TURRET GUN GAS EJECTION SYSTEM**; Frank Warlick; Washington, D.C.; Application September 20, 1950; Serial No. 185,899; 1 Claim; (Cl. 89–1).

2,798,413; **RECOILLESS GUN**; Kenneth R. Fowler; Warren, Pa.; Application December 12, 1946; Serial No. 715,674; 4 Claims; (Cl. 89–1.7).

2,798,415; **BREECHBOLT LOCK FOR AUTOMATIC FIREARMS**; Bernard Maillard; Geneva, Switzerland; assignor to Company "Brevets Aero-Mecaniques" S.A.; Geneva, Switzerland; a society of Switzerland; Application December 18, 1953; Serial No. 399,127; Claims priority; application Luxemburg December 24, 1952; 3 Claims; (Cl. 89–129).

July 16, 1957

2,799,103; **CARTRIDGE EXTRACTORS**; Rowland J. Kopf; Rocky River; and Roger Marsh; Hudson, Ohio; assignors to Ramset Fasteners, Inc.; a corporation of Delaware; Application April 16, 1954; Serial No. 423,556; 8 Claims; (Cl. 42–25).

July 23, 1957

2,799,957; **BOX MAGAZINE FOR CARTRIDGES IN A U-SHAPED LOOP**; Nicholas D. Kintzer; Watertown, Conn.; assignor to the United States of America as represented by the Secretary of the Army; Application June 30, 1955; Serial No. 519,295; 12 Claims; (Cl. 42–50).

2,799,958; **FLAG EXTRACTOR FOR GUN**; Gerhard A. Nothmann; Chicago; and Eugene S. Wassel; Cicero, Ill.; assignors to the United States of America as represented by the Secretary of the Army; Application April 7, 1954; Serial No. 421,713; 9 Claims; (Cl. 42–68).

2,799,959; **NITRIDED GUN BARREL WITH CHROMIUM DEPOSIT**; Elburt F. Osborn; State College, Pl.; assignor to the United States of America as represented by the Secretary of War; Application June 11, 1947; Serial No. 753,980; 4 Claims; (Cl. 42–76).

2,800,057; **FIRING PIN RETRACTING MECHANISM**; Owen D. Hoopes; Latham, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Application September 4, 1953; Serial No. 378,695; 4 Claims; (Cl. 89–28); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,800,058; **GUNNER'S CONTROL HANDLE FOR A FIRE CONTROL SYSTEM**; Arthur T. Henshall, Baltimore; and Charles C. Tonlinson, Glen Burnie, Md.; assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Application May 11, 1954; Serial No. 429.141; 7 Claims; (Cl. 89–41).

2,800,059; **GAS OPERATED RIFLE**; John M. Miller; Poughkeepsie, N.Y.; Application June 5, 1953; Serial No. 359,847; 3 Claims; (Cl. 89–193)

July 30, 1957

2,800,837; **BREECH BLOCK FOR A GUN**; Karl Bertil Brathe; Kariskoga, Sweden; assignor to Aktiebolaget Bofors; Bofors, Sweden; a corporation of Sweden; Application October 21, 1952; Serial No. 316,034; Claims priority; application Sweden October 24, 1951; 10 Claims; (Cl. 89–24).

August 6, 1957

2,801,485; **SPRING FINGER FOR MAGAZINES**; Roger Marsh; Hudson, Ohio; assignor to Weapons, Inc.; Hudson, Ohio; a corporation of Ohio; Application May 4, 1955; Serial No. 505,885; 3 Claims; (Cl. 42–50).

2,801,573; **CARTRIDGE CHAMBER SEAL FOR AUTOMATIC FIREARMS WITH REVOLVER DRUM**; Fritz Herlach and Friedrich Linder; Zurich, Switzerland, assignors to Machine Tools Works Oerlikon; Administration Company; Zurich-Oerlikon; Switzerland; a company of Switzerland; Application March 22, 1951; Serial No. 216,882; 3 Claims; (Cl. 89–13).

2,801,574; **GUN PROTECTIVE DEVICE**; Paul F. Peterson, Palos Verdes Estates, Calif.; assignor to North American Aviation, Inc.; Application August 11, 1955; Serial No. 527,727; 7 Claims; (Cl. 89–13).

2,801,575; **DRUM COOLING DEVICE**; Donald P. Grover; Chicago, Ill.; assignor, by mesme assignments, to the United States of America as represented by the Secretary of the Army; Application August 29, 1956; Serial No. 606,938; 3 Claims; (Cl. 89–14).

August 13, 1957

2,802,400; **BREECH MECHANISM**; James M. Edmund; Montgomery County, Md.; assignor to the United States of America as represented by the Secretary of the Navy; Application March 23, 1955; Serial No. 496,353; 6 Claims; (Cl. 89–24); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,802,401; **COIL AND BUFFER SPRING SYSTEM FOR A GUN MOUNT**; Edward H. Cabaniss, Newton C. Garland, and Albert L. Hardy; Schenectady; Jossph B. Gibbons, West Albany; and Leon Webster Frayer, Schenectady, N.Y.; assignors to the United States of America as represented by the Secretary of the Air Force; Application May 25, 1953; Serial No. 357,212; 1 Claim; (Cl. 89–44).

August 20, 1957

2,803,079; **LOCKING DEVICE FOR BOLT ACTION RIFLES**; John T. Hellman, Frankfort, Ky.; Application September 7, 1955; Serial No. 532,979; 1 Claim; (Cl. 42–16).

2,803,080; **CARTRIDGE DEFLECTOR FOR SHOTGUNS**; Ernest P. Simmons; Kansas City, Kans.; assignor to Olin Matheson Chemical Corporation, a corporation of Virginia; Application January 20, 1955; Serial No. 482,941; 3 Claims; (Cl. 42–25).

2,803,170; **AIRCRAFT GUN TURRET**; Walter L. Black, Upper Falls, Md.; assignor to the Glenn L. Martha Company; Middle River, Md.; a corporation of Maryland; Application February 13, 1951; Serial No. 210,780; 6 Claims; (Cl. 89–37.5).

August 27, 1957

2,803,907; **TELESCOPIC SIGHT MOUNT FOR FIREARMS**; William R. Weaver, El Paso, Tex.; Application November 3, 1952, Serial No. 318,417; 4 Claims. (Cl. 42–1).

2,803,908; **FIREARM WITH INTERCONNECTED BOLT LOCK AND FIRING MECHANISM**; Odis Raley, Paragould, Ark.; Application April 7, 1954, Serial No. 421,514; 12 Claims. (Cl. 42–22).

September 3, 1957

2,804,804; **APPARATUS FOR IMPELLING A PROJECTILE**; James M. Cumming, San Marino, Calif., Application June 30, 1952, Serial No. 296,517; 2 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,804,806; **PRE-ENGRAVED PROJECTILES AND GUN FOR FIRING SAME**; Frank R. Simpson, Upper Darby, Pa., assignor to the United States of America as represented by the Secretary of the Army; Application June 14, 1951, Serial No. 231,493; 9 Claims. (Cl. 89–33).

2,804,807; **CLOSED CARTRIDGE BELT LINK CONVERTIBLE TO AN OPEN SIDE STRIPPING STRUCTURE**; Paul H. Dixon, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application September 29, 1954, Serial No. 459,220; 10 Claims. (Cl. 89–35).

2,804,808; **RETRACTABLE FIRING ANVIL**; Edward A. Humphrey, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application October 21, 1954, Serial No. 463,838; 3 Claims. (Cl. 89–135); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,804,809; **SEMI-AUTOMATIC RIFLE**; Thomas L. Frates, Concord, Calif.; Application June 13, 1952, Serial No. 293,341; 10 Claims. (Cl. 89–150).

2,804,810; **RECEIVER CAM**; Charles H. Stevens, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 10, 1953, Serial No. 360,853; 6 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 10, 1957

2,805,602; **BLANK CARTRIDGE ADAPTER FOR RIFLES**; Chester F. Moore, Columbus, Ga.; Application March 18, 1954, Serial No. 417,010; 1 Claim. (Cl. 89–14).

2,805,603; **GUN AIMING MECHANISM WITH ASSOCIATED TRIGGER RELEASE MECHANISM AND SUPPORTING MOUNT**; C. Walton Musser, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of the Army; Application February 24, 1953, Serial No. 338,627; 15 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,805,604; **CAMMED FIRING PIN**; Edward A. Humphrey, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application October 13, 1954, Serial No. 462,128; 3 Claims. (Cl. 89–135).; (Granted under Title 35, U.S. Code (1952), sec. 266).

2,805,605; **SEAR DEVICE FOR AN AUTOMATIC FIREARM**; Edward C. Lee, Detroit, Mich., assignor to the United States of America as represented by the Secretary of the Army; Application December 23, 1953, Serial No. 400,150; 6 Claims. (Cl. 89–136).

September 17, 1957

2,806,316; SPRING-PRESSED PAWL FOR ROTATING REVOLVER CYLINDER; William B. Ruger, Westport, Conn., assignor to Strum, Ruger and Company, Southport, Conn., a corporation of Connecticut; Application January 30, 1956, Serial No. 562,305; 2 Claims. (Cl. 42–59).

2,806,409; COOLING MECHANISM FOR MACHINE GUNS AND THE LIKE; William P. Purcelia, Derby, and Joseph F. Purcelia, Hamden, Conn.; Application May 29, 1951, Serial No. 228,852; 3 Claims. (Cl. 89–14).

September 24, 1957

2,807,112; GRENADE LAUNCHER FOR A GUN WITH A GAS CYLINDER; John C. Garand, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 24, 1954, Serial No. 418,486; 7 Claims. (Cl. 42–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,807,113; AUTOMATIC RELOADING MECHANISM FOR BOLT ACTION RIFLE; Jessie T. Ivy, Seattle, Wash.; Application May 18, 1956, Serial No. 585,761; 4 Claims. (Cl. 42–16).

2,807,114; EJECTOR FOR ROTATING BREECH AUTOMATIC GUNS; James Victor Shepherd, Farnborough, England, assignor to the Minister of Supply in Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, London, England; Application March 25, 1954, Serial No. 418,708; 13 Claims. (Cl. 42–68).

2,807,195; CARTRIDGE CASE HOLDER AND EXTRACTOR AND BREECH MECHANISM FOR HEAVY CALIBER RECOILLESS GUN; Clarence Walton Musser, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of War; Application July 1, 1948, Serial No. 36, 508; 7 Claims. (Cl. 89–21); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,807,196; SAFETY DEVICE FOR AUTOMATIC FIREARMS; Erik Saetter-Lassen, Hellerup, Denmark; Application April 14, 1953, Serial No. 348,696; 4 Claims. (Cl. 89–142).

October 1, 1957

2,807,902; CARTRIDGE EXTRACTORS; Rowland J. Kopf, Rocky River, Ohio, assignor, by mesne assignments, to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application April 16, 1954, Serial No. 423,650; 7 Claims. (Cl. 42–25).

2,807,903; ADJUSTABLE CHOKE; Warren R. Wheeler, San Francisco, Calif.; Application November 9, 1953, Serial No. 390,813; 1 Claim. (Cl. 42–79).

2,807,904; FOLDING BIPOD ASSEMBLY; Walter J. Kreske, Newton Center, Mass.; Application January 15, 1951, Serial No. 205,973; 9 Claims. (Cl. 42–94).

2,807,986; BORE EVACUATOR FOR GUN BARRELS; Wellington R. Howard, Falls Church, Va., and Herman P. Matson, Washington, D. C., assignors to the United States of America as represented by the Secretary of the Army; Application July 3, 1953, Serial No. 366,081; 6 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,807,987; DIRECTIONAL MOUNTING FOR A GUN; Roy Gilbert Vickers, Grantham, England, assignor to "Brevets Aero-Mecaniques S. A.," Geneva, Switzerland, a society of Switzerland; Application July 16, 1954, Serial No. 443,861; Claims priority, application Great Britain July 22, 1953; 6 Claims. (Cl. 89–41).

October 15, 1957

2,809,560; MUZZLE BRAKE; Herman A. Matson, Washington, D. C., and Paul M. Netzer, Arlington, Va., assignors to the United States of America as represented by the Secretary of the Army; Application December 15, 1953, Serial No. 398,456; 4 Claims. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,809,561; POWDER CASE LOCK FOR BREECH MECHANISM; James M. Edmund, Montgomery County, Md., assignor to the United States of America as represented by the Secretary of the Navy; Application October 29, 1954, Serial No. 465,762; 2 Claims. (Cl. 89–24); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,809,562; AMMUNITION FEED MECHANISM FOR AUTOMATIC GUNS; Heinrich Herlach, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland;

Application August 14, 1952, Serial No. 304,266; Claims priority, application Switzerland August 18, 1951; 7 Claims. (Cl. 89–33).

2,809,563; **CARTRIDGE BELT LINK**; Alexander Hammer, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 29, 1953, Serial No. 334,105; 1 Claim. (Cl. 89–35).; (Granted under Title 35, U.S. Code (1952), sec. 266).

2,809,564; **GUN CONSTRUCTION**; Arthur J. Pope, Madison, Conn.; Application June 24, 1950, Serial No. 170,178; 4 Claims. (Cl. 89–128).

2,809,565; **FIRING MECHANISM FOR A REVOLVER-TYPE GUN**; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 8, 1954, Serial No. 403,082; 6 Claims. (Cl. 89–156); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 22, 1957

2,810,325; **GUN CHARGER**; John M. Desilerres, Rolling Hills, and Paul F. Peterson, Palos Verdes Estates, Calif., assignors to North American Aviation, Inc.; Application February 14, 1955, Serial No. 487,852; 9 Claims. (Cl. 89–1).

October 29, 1957

2,811,084; **SUSPENDED STOWAGE MAGAZINES**; Frederick Jack Cook, Farndon, Newark, and Jack Knowles, Grantham, England, assignors to Brevets Aero-Mecaniques S. A., Geneva, Switzerland, a society of Switzerland; Application January 14, 1955, Serial No. 481,922; Claims priority; application Great Britain; January 18, 1954; 1 Claim. (Cl. 89–34).

November 5, 1957

2,811,901; **METHOD AND APPARATUS FOR SABOT REMOVAL**; Irwin R. Barr, Kingsville, Md., assignor to Aircraft Armaments, Inc., Baltimore, Md., a corporation of Maryland; Application August 23, 1954, Serial No. 451,537; 5 Claims. (Cl. 89–14).

2,811,902; **MECHANICAL BOLT UNLOCKING MECHANISM FOR RECOILING BARREL GUNS**; Paul H. Dixon, Rockford, Ill., assignor to the United States of America as represented by the Secretary of the Army; Application January 18, 1952, Serial No. 267,132; 11 Claims. (Cl. 89–165).

November 12, 1957

2,812,693; **FORAMINOUS GUN MUZZLE**; James C. Hartley, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application May 11, 1953, Serial No. 354,298; 12 Claims. (Cl. 89–14).

November 19, 1957

2,813,362; **SEAR-CONTROLLING MECHANISM FOR FIREARMS**; Oswald O. Sunderland, Fairfield, Conn.; Application June 27, 1955, Serial No. 518,164; 10 Claims. (Cl. 42–69).

November 26, 1957

2,814,143; **SINGLE TRIGGER MECHANISM FOR DOUBLE-BARREL GUNS**; Jacob W. Anderson, Kettle River, Minn.; Application August 3, 1953, Serial No. 371,836; 4 Claims. (Cl. 42–42).

2,814,234; **GUN INSTALLATION WITH STRUCTURE PIVOTABLE WITH RESPECT TO LINE OF FIRE**; Bernard Maillard, Geneva, Switzerland, assignor to "Brevets Aero-Mecaniques" S. A., Geneva, Switzerland, a society of Switzerland; Application April 6, 1954, Serial No. 421,227; Claims priority, application Luxemburg April 7, 1953; 3 Claims. (Cl. 89–41).

2,814,235; **FEED SWITCH**; Joseph L. Johnston, Detroit, Mich., assignor, by nesne assignments, to the United States of America as represented by the Secretary of the Army; Application May 21, 1954, Serial No. 431,310; 6 Claims. (Cl. 89–135).

December 3, 1957

2,814,971; **GUN CHARGER;** Thomas F. Fitzgibbon, Los Angeles, Calif., assignor to North American Aviation, Inc.; Application May 4, 1953, Serial No. 352,734; 5 Claims. (Cl. 89–1).

2,814,972; **SAFETY DEVICE FOR GAS-OPERATED AUTOMATIC SHOTGUNS**; Ernest P. Simmons, Jr., Overland Park, Kans.; Application April 10, 1956, Serial No. 577,323; 2 Claims. (Cl. 89–193).

December 10, 1957

2,815,602; **BARREL CHAMBER FOR CARTRIDGES OF DIFFERENT LENGTH**; Homer W. Young, Ilion, N. Y., assignor to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application February 23, 1954, Serial No. 411,829; 4 Claims. (Cl. 42–76).

2,815,699; **GUN FEED MECHANISM**; Rodger W. Davis, Washington, D. C., assignor, by mesne assignments, to Republic Aviation Corporation, near Farmingdale, N. Y., a corporation of Delaware; Application August 11, 1952, Serial No. 303, 672; 7 Claims. (Cl. 89–33).

December 17, 1957

2,816,484; **AUTOMATIC FIREARM OF THE BLOW BACK TYPE**; Richard R. Grages, St. Louis, Mo.; Application August 27, 1951, Serial No. 243,801; 2 Claims. (Cl. 89–194).

December 24, 1957

2,817,172; **BARREL LOCK FOR RIFLES**; George A. Lehman, Bellevue, Wash.; Application February 6, 1956, Serial No. 563,564; 1 Claim. (Cl. 42–1).

2,817,173; **CAM OPERATED EXTRACTOR**; Donald P. Grover, Chicago, and Bernard Stevens, Skokie, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application March 11, 1954, Serial No. 415,712; 1 Claim. (Cl. 42–68).

2,817,174; **TAKE-DOWN DEVICE FOR FIREARMS**; Carl F. Liedke, North Haven, Conn., assignor to The High Standard Manufacturing, Corporation, Hamden, Conn., a corporation of Connecticut; Application August 17, 1954, Serial No. 450,338; 6 Claims. (Cl. 42–75).

December 31, 1957

2,817,917; **CARTRIDGE LIFTER BIASED BY SPRING WITH TOGGLE ACTION**; Carl T. Colliander, West Cheshire, Conn., assignor of one-half to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut, and one-half to Sears, Roebuck and Co., Chicago, Ill., a corporation of Illinois; Application July 30, 1954, Serial No. 446,905; 1 Claim. (Cl. 42–17).

2,817,999: **AUTOMATIC GUN LINK CHUTES**; Clarence Duncan Cowburn, Croston, near Preston, and Frank William Proudlove,; Lytham, England; assignors to the English Electric Company Limited; London, England; a British company; Application April 13, 1956; Serial No. 578,026; Claims priority, application Great Britain April 22, 1955; 1 Claim.; (Cl. 89–33).

January 7, 1958

2,818,669; **BOLT LOCK FOR A RIFLE**; Claude Alfred Perry, Olton, and Roger David Wackrow, Handswooth, England, assignors to The Birmingham Small Arms Company Limited, Small Health, Birmingham, England; Application February 19, 1954, Serial No. 411,524; 4 Claims. (Cl. 42–16).

2,818,780; **COUPLING DEVICES OF MORTAR-TYPE GUNS**; Arvo Ensio Saloranta and Martti Ensio Saloranta, Helsingfors, Finland; Application December 27, 1954, Serial No. 477,848; 6 Claims. (Cl. 89–37).

2,818,782; **DIRECTING APPARATUS**; Joseph Raymond Jasse, Paris, France, assignor to Societe Nouvelle des Etablissements Brandt, Paris, France, a French body corporate; Application May 12, 1953, Serial No. 354,454; Claims priority, application France May 14, 1952; 1 Claim. (Cl. 89–41).

2,818,783; **ELECTROMAGNETIC RECOIL SYSTEM FOR A GUN**; George R. Carlson, Glencoe, Ahmed D. Kafadar, Chicago, and Severin Raynor, Winnetka, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application April 22, 1953, Serial No. 350,402; 10 Claims. (Cl. 89–42).

2,818,784; **BLOCK ACTUATOR FOR A REVOLVER-TYPE GUN**; Charles H. Stevens, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application June 19, 1953, Serial No. 362,977; 3 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,818,785; **IMPROVEMENTS IN AUTOMATIC GUNS HAVING A DETACHABLE BARREL**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S. A., Geneva, Switzerland, a Swiss society; Application July 22, 1954, Serial No. 445,099; Claims priority, application Luxemburg July 27, 1953; 4 Claims. (Cl. 89–193).

January 14, 1958

2,819,550; **GUN SAFETY ATTACHMENT**; Arlon E. Fischer, Omaha, Nebr.; Application June 11, 1954, Serial No. 436,154; 1 Claim. (Cl. 42–70).

2,819,551; **SAFETY FOR BOLT ACTION FIREARMS**; Albert T. Balerl, Hayden, Colo.; Application May 4, 1956, Serial No. 582,872; 1 Claim. (Cl. 42–70).

2,819,653; **FIRE CONTROL MEANS FOR A RECOILING TWIN-GUN**; Karl Bertil Brathe, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Application December 3, 1952, Serial No. 323,821; Claims priority, application Sweden February 11, 1952; 11 Claims. (Cl. 89–27).

January 21, 1958

2,820,313; **BOLT-ACTION RIFLE AND FIRING MECHANISM THEREFOR**; Claude Alfred Perry, Olton, Birmingham, and Roger David Wackrow, Handsworth, England, assignors to The Birmingham Small Arms Company Limited, Small Health, Birmingham, England; Application February 19, 1954, Serial No. 411,525; 3 Claims. (Cl. 42–16).

2,820,400; **CARTRIDGE LINK AND FEEDWHEEL FOR A REVOLVER-TYPE GUN**; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application February 3, 1954, Serial No. 408,051; 6 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,820,401; **MACHINE GUN ANTI-JAMMING DEVICE**; John Gerick, Los Angeles, Calif., assignor to Frank A. Pachmayr, Culver City, Calif.; Application May 17, 1954, Serial No. 430,159; 10 Claims. (Cl. 89–33).

January 28, 1958

2,821,040; **SAFETY FOR FIREARMS**; James L. Tatman, Ludington, Mich.; Application December 29, 1955, Serial No. 556,200; 7 Claims. (Cl. 42–70).

2,821,116; **COCKING DEVICE FOR AUTOMATIC FIREARMS**; Oskar Schwager and Fritz Herlach, Zurich, Switzerland, assignors to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Application December 17, 1952, Serial No. 326,398; 3 Claims. (Cl. 89–1).

2,821,117; **UNDERCARRIAGE FOR A FIREARM**; Karl Sten Rudolf Hultgren, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish corporation; Application January 27, 1956, Serial No. 561,832; Claims priority, application Sweden January 29, 1955; 13 Claims. (Cl. 89–37).

2,821,118; **AUTOMATIC GUNS INCLUDING A RECOILING SYSTEM**; Alexandre Billard, Paris, France, assignor to Societe d'Exploitation des Materiels Hispano-Suiza, Bois-Colombes, France, a society of France; Application January 21, 1954, Serial No. 405,426; Claims priority, application France January 30, 1953; 2 Claims. (Cl. 89–137).

February 4, 1958

2,821,885; GUN BREECH CLOSING MEANS; Paul W. Burk, Washington, D. C., assignor to the United States of America as represented by the Secretary of the Navy; Application August 2, 1951, Serial No. 240,019; 5 Claims. (Cl. 89–24); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,821,886; FEEDING MECHANISM FOR AUTOMATIC FIREARM; Harvey H. Friend, Hamden, and Carl F. Liedke, North Haven, Conn., assignors to the United States of America as represented by the Secretary of the Army; Application April 5, 1954, Serial No. 421,207; 9 Claims. (Cl. 89–33).

2,821,887; AUTOMATIC GUNS; Charles J. Gross, Melrose, Henry B. Kimball, Marblehead, Wilbur H. Farley, Ipswich, and Harold W. Bishop, Essex, Mass., assignors to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey; Application July 27, 1954, Serial No. 446,052; 3 Claims. (Cl. 89–33).

2,821,888; BELT FEED MECHANISMS FOR AUTOMATIC FIREARMS; Bernard Maillard, Geneva, Switzerland, Original application March 25, 1952, Serial No. 278,349, now Patent No. 2,750,845, dated June 19, 1956. Divided and this application May 4, 1956, Serial No. 582,870; Claims priority, application Luxembourg March 27, 1951; 3 Claims. (Cl. 89–33).

February 11, 1958

2,822,730; READY RACKS FOR SHELLS; John W. Brennan, Salem, and Richard W. Daniels, Weaham, Mass., assignors to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey; Application March 21, 1955, Serial No. 495,510; 3 Claims. (Cl. 89–1).

2,822,731; GUN MOUNTING WITH MAGAZINE AND SPENT AMMUNITION COLLECTOR; Leonard Stevens, Grantham, England, assignor to Brevets Aero-Mecaniques S. A., Geneva, Switzerland, a Swiss society; Application October 14, 1954, Serial No. 462,325; Claims priority, application Great Britain, October 15, 1953; 3 Claims. (Cl. 89–37).

2,822,732; AIRCRAFT WITH JET PROPULSION ENGINE AND GUN FIRING MEANS; Thomas Laidler, Metcalfe, Thorpe Grange, Thorpe, Ashbourne, England, assignor to Rolls-Royce Limited, Derby, England, a British company; Application May 16, 1956, Serial No. 585,190; Claims priority, application Great Britain May 25, 1955; 18 Claims. (Cl. 89–133).

February 18, 1958

2,823,480; RECEIVER CONSTRUCTION; Thomas R. Robinson, Jr., New Haven, Conn., assignor to The Marlin Firearms Company, New Haven, Conn., a corporation of Connecticut; Application April 2, 1954, Serial No. 420,605; 4 Claims. (Cl. 42–75).

2,823,587; LOADING AND RAMMING MECHANISM FOR SEMI-AUTOMATIC GUNS; George A. Chadwick, Washington Grove, Md., and Phillias H. Girouard, John H. Sihler, Carl V. Hickman, and David Wertman, Washington, D.C.; Application November 28, 1942, Serial No. 467,182; 136 Claims. (Cl. 89–4); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,823,588; AMMUNITION BOOSTER; William A. Webb and William B. Hipsley, Towson, Md.; Application April 6, 1955, Serial No. 499,704; 10 Claims. (Cl. 89–33).

2,823,589; SELECTIVE FIRE CONVERTER AND RATE REDUCER; Alonzo F. Gaidos, Redwood City, Calif.; Application March 31, 1952, Serial No. 279,623; 18 Claims. (Cl. 89–131).

February 25, 1958

2,824,400; ROCKABLE BREECH BOLT LOCKING BLOCK; Lexie Ray Crittendon, Wilmington, Del., and Ellis William Hailston, Ilion, N. Y., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Original application January 19, 1955, Serial No. 482,726, now Patent No. 2,751,702, dated June 26, 1956. Divided and this application February 8, 1956, Serial No. 564,249; 8 Claims. (Cl. 42–16).

2,824,401; CRANK LINK EXTRACTOR FOR GUN; William D. Bobco, Berwyn, and Eugene S. Wassel, Cicero, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application April 5, 1954, Serial No. 421,209; 6 Claims. (Cl. 42–68).

2,824,402; BREECH BOLT AND FIRING PIN SAFETY MECHANISM FOR FIREARMS; Joseph F. Fischer, Grand Rapids, Mich.; Application June 21, 1956, Serial No. 592,846; 14 Claims. (Cl. 42–70).

2,824,497; FEEDER MECHANISM FOR A FIREARM; Raymond A. Bond, Watertown, Conn., and Burns Darsie, Rockford, Ill., assignors to the United States of America as represented by the Secretary of the Army; Application March 30, 1956, Serial No. 575,282; 14 Claims. (Cl. 89–33).

March 4, 1958

2,825,170; **BARREL, FOREARM AND RECEIVER ASSEMBLY MECHANISM FOR SHOTGUNS**; Ernest P. Simmons, Kansas City, Kans., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 2, 1954, Serial No. 472,634; 5 Claims. (Cl. 42–75).

March 11, 1958

2,825,991; **MAGAZINE ARRANGEMENT FOR MEDIUM CALIBRE GUNS**; Rudolf Stadelmann, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a Swiss company; Application November 7, 1955, Serial No. 545,456; Claims priority, application Switzerland, November 11, 1954; 5 Claims. (Cl. 42–50).

2,826,121; **MACHINE GUN TRIGGER MECHANISM**; Nicholas A. Dodich, Waukesha, Wis.; Application April 29, 1954, Serial No. 426,322; 9 Claims. (Cl. 89–140).

2,826,122; **FIRING DEVICE FOR A REVOLVER-TYPE AUTOMATIC GUN WITH A RECOIL UNIT**; George H. Bornheim and Herve J. Ouellette, Springfield, Mass., assignors to the United States of America as represented by the Secretary of the Army; Application October 10, 1955, Serial No. 539,704; 7 Claims. (Cl. 89–157); (Granted under Title 35, U.S. Code (1952), sec. 266).

March 18, 1958

2,826,847; **HYDRAULIC ACTUATED FIRING PIN FOR A FIREARM**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application August 13, 1954, Serial No. 449,812; 3 Claims. (Cl. 42–69); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,826,848; **HAND HOLD FOR GUNS**; Thomas E. Davies, Morgantown, W. Va.; Application August 26, 1955, Serial No. 530,666; 2 Claims. (Cl. 42–71).

2,826,962; **LINK EJECTION SYSTEM**; Donald P. Grover, Chicago, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of Army; Application September 11, 1956, Serial No. 609,330; 1 Claim. (Cl. 89–33).

March 25, 1958

2,827,728; **GAUGE ADAPTOR FOR AUTOMATIC SHOTGUNS**; Ernest P. Simmons, Kansas City, Kans.; Application June 11, 1956, Serial No. 590,717; 6 Claims. (Cl. 42–17).

April 1, 1958

2,828,568; **CARTRIDGE INDICATING MAGAZINE FOR AUTOMATIC PISTOLS AND OTHER FIREARMS**; Edwin G. Sakewitz, Teaneck, N. J.; Application June 17, 1955, Serial No. 516,269; 2 Claims. (Cl. 42–50).

2,828,569; **CHOKING DEVICE FOR FIREARMS**; Herbert Welles Steane, West Hartford, Conn., assignor to The Poly Choke Company, Incorporated, Tariffville, Conn., a corporation of Connecticut; Application March 30, 1955, Serial No. 498,006; 3 Claims. (Cl. 42–79).

April 8, 1958

2,829,562; **CARTRIDGE FEEDING MECHANISM**; Richard M. La Rue, Dahlgren, Va., assignor to the United States of America as represented by the Secretary of the Navy; Application February 3, 1953, Serial No. 334,992; 2 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,829,563; **SEAR-DISCONNECTOR MECHANISM**; Wallace B. Butler, Branford, Conn.; Application April 14, 1955, Serial No. 501,253; 9 Claims. (Cl. 89–144).

April 15, 1958

2,830,397; **REVOLVER WITH SWING-OUT CYLINDER**; Lester F. Mulno, Worcester, Mass., assignor to Harrington & Richardson, Inc., Worcester, Mass., a corporation of Massachusetts; Application July 26, 1956, Serial No. 600,322; 6 Claims. (Cl. 42–62).

2,830,398; **EJECTOR FOR BALL AND CAP CYLINDER TYPE REVOLVER**; William E. Donohue, Fort Worth, Tex., assignor of one-half to Cassel D. Hibbs, Fort Worth, Tex.; Application June 4, 1956, Serial No. 589,203; 1 Claim. (Cl. 42–68).

2,830,498; **MULTIPLE CARTRIDGE CLIP FEEDING MECHANISMS FOR AUTOMATIC GUNS**; Bernard Maillard, Geneva, Switzerland, assignor to "Brevets Aero-Mecaniques," Geneva, Switzerland, a society of Switzerland; Application October 22, 1954, Serial No. 464,143; 15 Claims. (Cl. 89–33).

2,830,499; **LOADING DEVICE FOR EXTERNALLY MOUNTED TANK GUNS**; Georges Even, Paris, France; Application September 30, 1955, Serial No. 537,840; Claims priority, application France October 11, 1954; 5 Claims. (Cl. 89–47).

April 22, 1958

2,831,287; **CARTRIDGE CHAMBER WITH ABUTMENTS**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets "Aero-Mechaniques" S. A., Geneva, Switzerland, a Swiss society; Application February 7, 1955, Serial No. 486,654; Claims priority, application Luxemburg, February 16, 1954; 4 Claims. (Cl. 42–76).

2,831,401; **BREECH MECHANISMS FOR OPEN-CHAMBER GUNS**; David Dardick, New York, N. Y., assignor to Dardick Corporation, a corporation of Delaware; Application September 27, 1955, Serial No. 536,895; 11 Claims. (Cl. 89–17).

2,831,402; **VARIABLE RATE TIMER AND PROGRAMMER FOR FIRING MACHINE GUNS**; Norman Taslitt, Hyattsville, Md., assignor to the United States of America as represented by the Secretary of the Navy; Application April 22, 1954, Serial No. 425,057; 11 Claims. (Cl. 89–28); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,831,403; **SLIDING BREECHBLOCK LOCKING MECHANISM FOR SELF-LOADING FIREARMS**; Bernard Maillard, Geneva, Switzerland, assignor to Society "Brevets Aero-Mecaniques," S. A., Geneva, Switzerland, a society of Switzerland; Original application March 30, 1951, Serial No. 218,370, now Patent No. 2,756,640, dated July 31, 1956. Divided and this application June 27, 1955, Serial No. 518,307; Claims priority, application Luxemburg March 30, 1950; 4 Claims. (Cl. 89–187).

2,831,404; **RECOIL BUFFER FOR GUNS**; Frederick W. Sampson and Allen L. Everitt, Dayton, Ohio, assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware; Application February 28, 1952, Serial No. 273,831; 1 Claim. (Cl. 89–198).

April 29, 1958

2,832,165; **BOLT TURNING ATTACHMENT FOR RIFLE**; Jessie T. Ivy, Seattle, Wash.; Application August 25, 1955, Serial No. 530,449; 5 Claims. (Cl. 42–16).

2,832,166; **PISTOL GRIP ATTACHMENT FOR RIFLE**; Jessie T. Ivy, Seattle, Wash.; Application June 18, 1956, Serial No. 592,157; 2 Claims. (Cl. 42–72).

2,832,167; **BARREL BREAKING ACTION FOR GUNS**; William E. Fox, Dowagiac, Mich.; Application April 27, 1956, Serial No. 581,034; 9 Claims. (Cl. 42–75).

2,832,266; **AUTOMATIC PISTOL**; Oswald Olds Sunderland, Fairfield, Conn.; Application November 8, 1952, Serial No. 319,458; 6 Claims. (Cl. 89–195).

May 6, 1958

2,833,182; **AMMUNITION STORING AND FEEDING DEVICE**; Chester E. Houston, Marietta, Ga., and Maurice C. Vercoe, Burlington, Vt., assignors to General Electric Company, a corporation of New York; Application December 5, 1955, Serial No. 551,473; 7 Claims. (Cl. 89–33).

May 13, 1958

2,834,137; **MAGAZINE CHARGER**; William R. Kunz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 15, 1956, Serial No. 591,769; 1 Claim. (Cl. 42–87); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,834,255; **RECOILLESS FIREARM AND AMMUNITION THEREFOR**; C. Walton Musser, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of the Army; Application August 27, 1952, Serial No. 306,743; 1 Claim. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,834,256; **RAPID FIRE GUN SLIDE HYDRAULIC CONTROL SYSTEM**; David Wertman, Kensington, Md.; Application April 19, 1955, Serial No. 502,536; 12 Claims. (Cl. 89–45).; (Granted under Title 35, U.S. Code (1952), sec. 266).

2,834,257; **INERTIA OPERATED RATE REDUCER FOR AUTOMATIC FIREARMS**; John C. Garand, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application February 15, 1954; Serial Number 410,466; 6 Claims. (Cl. 89–131); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 20, 1958

2,835,171; **ROTARY MAGAZINE GUN**; George Albert Lyon, Detroit, Mich.; Application March 14, 1952, Serial No. 276,575; 7 Claims. (Cl. 89–13).

May 27, 1958

2,835,998; **SLIDABLE BARREL GUN WITH A COMBINED SEAR AND COCKING MEMBER**; Mikkel Maerk, Lokken Verk, Norway; Original application April 22, 1952, Serial No. 283,710, now Patent No. 2,699,007, dated January 11, 1955. Divided and this application November 1, 1954, Serial No. 466,123; Claims priority, application Norway May 13, 1947; 7 Claims. (Cl. 42–10).

2,836,106; **RAMMER**; Robert G. Nutting, Glenview, and Robert F. Windstrup, Chicago, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Original application October 13, 1955, Serial No. 540,362. Divided and this application January 11, 1957, Serial No. 633,810; 1 Claim. (Cl. 89–33).

2,836,107; **SINGLE BLOCK ACTUATOR FOR A REVOLVER-TYPE GUN**; Earl R. Butler, Dayton, Ohio, and Kenneth A. Main, Ridgewood, N. J., assignors to the United States of America as represented by the Secretary of the Army; Application October 15, 1953, Serial No. 386,413; 1 Claim. (Cl. 89–156); (Granted under Title 35, U.S. Code (1952), sec. 266).

June 3, 1958

2,836,918; **SAFETY DEVICE FOR FIREARMS**; Stephen Pula, Adamsdale, Mass., and George Loparto, Cumberland, R. I., assignors of one-third to Joseph Marszalkowski, Cumberland, R. I.; Application August 24, 1955, Serial No. 530,264; 1 Claim. (Cl. 42–1).

2,836,919; **SMALL WEAPONS NOISE SIMULATOR**; Edwin R. du Bois, Glen Head, N. Y.; Application September 28, 1954, Serial No. 458,998; 18 Claims. (Cl. 42–57); (Granted under Title 35, U.S. Code (1952), sec. 266).

June 10, 1958

2,837,856; **DUAL COMPENSATOR HAVING SHOT CONTROLS FOR DOUBLE BARREL SHOTGUNS**; Humberto Ortiz Benitez, Mexico City, Mexico; Application March 21, 1955, Serial No. 495,609; 1 Claim. (Cl. 42–79).

June 24, 1958

2,839,861; **EXTRACTOR FOR RECOIL-OPERATED, REVOLVER-TYPE AUTOMATIC GUN**; Robert A. Rosenblum, Skokie, and Robert F. Windstrup, Chicago, Ill.; Application March 23, 1955, Serial No. 496,354; 5 Claims. (Cl. 42–68).

2,839,966; **SPLIT BREECH BLOCK**; John G. Lord, Swarthmore, Pa., assignor to the United States of America as represented by the Secretary of the Army; Application August 18, 1955, Serial No. 529,369; 7 Claims. (Cl. 89–22).

2,839,967; **GUN INTERFERENCE ELIMINATOR**; Clarence F. Hammer, Jr., Wilmington, Del., John A. Templeton, Silver Spring, Md., and John W. MacGregor, Columbus, Ohio, assignors to the United States of America as represented by the Secretary of the Navy; Application November 13, 1953, Serial No. 392,062; 6 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

July 1, 1958

2,840,944; **ADAPTOR FOR A MAGAZINE**; James F. Thompson, Chestertown, Md.; Application March 30, 1954, Serial No. 419,665; 1 Claim. (Cl. 42–50).

July 8, 1958

2,841,906; **SHOULDER FIREARM HAVING SEPARATE PROJECTILE AND POWDER MAGAZINES**; Edwin R. Michelson, Berkeley, Mo.; Application June 7, 1954, Serial No. 434,929; 7 Claims. (Cl. 42–17).

2,841,908; **TRIGGER ACTUATOR FOR FIREARMS**; Eugene Bourquin, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S. A., Geneva, Switzerland, a Swiss society; Application May 16, 1955, Serial No. 508,587; Claims priority, application Luxembourg May 26, 1954; 4 Claims. (Cl. 42–69).

2,841,909; **CONSTANT TORQUE-TYPE STRESS APPLIANCE FOR FIREARM BARRELS**; Lemuel M. Temple, North Haven, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application July 12, 1954, Serial No. 442,693; 4 Claims. (Cl. 42–75).

2,842,024; **ANTI-RECOIL GUN BARRELS**; John F. Mutter, Pendleton, Oreg.; Application December 7, 1954, Serial No. 473,652; 1 Claim. (Cl. 89–14).

2,842,031; **TURRET INSTALLATION WITH AMMUNITION FEED MECHANISM**; Quinton C. Johnson, Torrance, Calif., assignor to North American Aviation, Inc.; Application November 17, 1954, Serial No. 469,497; 9 Claims. (Cl. 89–37.5).

July 15, 1958

2,842,885; **FIRING PIN WITH PLASTIC SLEEVE FOR FIREARMS**; Robert L. Hillberg, West Cheshire, Conn., assignor to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut; Application July 27, 1954, Serial No. 446,053; 1 Claim. (Cl. 42–69).

2,843,021; **AMMUNITION BOOSTER WITH TORQUE LIMITING DEVICE**; James E. Chapman, Los Angeles, and Walter G. Johnston, Culver City, Calif., assignors to The Garrett Corporation, Los Angeles, Calif., a corporation of California; Application December 1, 1952, Serial No. 323,402; 8 Claims. (Cl. 89–33).

2,843,022; **MOVABLE JAW GUN ENCLOSURE**; Rene W. Bonnette and Robert B. Tassie, Burlington, Vt., assignors to General Electric Company, a corporation of New York; Application May 11, 1955, Serial No. 507,598; 12 Claims. (Cl. 89–37.5).

2,843,023; **RECOIL MECHANISM FOR RECOIL-OPERATED FIREARMS**; Louis Debult, Grenoble, France, assignor to Etablissements Merlin & Gerin, Grenoble, France; Application July 14, 1955, Serial No. 521,945; Claims priority, application France August 31, 1954; 4 Claims. (Cl. 89–132).

July 22, 1958

2,843,960; **SAFETY DEVICE FOR FIREARMS**; Sven Gunnar Olof Larsson, Huskvarna, Sweden, assignor to Husqvarna Vapenfabriks Aktiebolag, Huskvarna, Sweden, a corporation of Sweden; Application March 27, 1954, Serial No. 418,703; 6 Claims. (Cl. 42–70).

July 29, 1958

2,844,902; **FOUNTAIN PEN PISTOL**; Sol Harry Gaylord, Jr., and James Tollinger, Chicago, Ill., assignors to Gaylord Products, Incorporated, Chicago, Ill., a corporation of Delaware; Application August 12, 1954, Serial No. 449,416; 2 Claims. (Cl. 42–1).

2,844,903; **VARIABLE LENGTH BOLT LEVER**; Richard H. Colby, South Hadley, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application November 17, 1955, Serial No. 547,591; 4 Claims. (Cl. 42–16); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,844,904; **FIREARM HAVING A FLOATING RECEIVER**; Wallace B. Butler, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Original application July 29, 1955, Serial No. 525,136. Divided and this application October 17, 1956, Serial No. 616,543; 3 Claims. (Cl. 42–75).

2,844,905; **TELESCOPIC UNIPOD**; C Walton Musser, Albert Benditt, and Lloyd W. Insetta, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Application November 21, 1952, Serial No. 321,962; 6 Claims. (Cl. 42–94); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,845,001; **MANUAL CHARGER FOR A FIREARM**; Robert L. Hillberg, West Cheshire, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application November 30, 1955, Serial No. 550,233; 3 Claims. (Cl. 89–1).

2,845,005; RELINKING FEEDER; Charles H. Stevens, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 31, 1956, Serial No. 562,618; 1 Claim. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,845,006; ROLLER DRUM SUPPORT FOR A REVOLVER-TYPE GUN; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application March 12, 1954, Serial No. 415,989; 1 Claim. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,845,007; PIVOTED CHAMBER WEAPON; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application August 18, 1955, Serial No. 529,365; 9 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,845,008; VALVE ADJUSTMENT MEANS FOR A GAS-OPERATED FIREARM; Irving H. Atwood, Jr., Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application April 15, 1957, Serial No. 653,046; 1 Claim. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 5, 1958

2,845,737; MECHANICAL RECOIL COMPENSATOR; Michael G. Hoyer, White Plains, N. Y.; Application October 10, 1955, Serial No. 539,372; 4 Claims. (Cl. 42–1).

2,845,738; CARTRIDGE FEEDING MECHANISM; Wallace B. Butler, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application May 23, 1955, Serial No. 510,352; 2 Claims. (Cl. 42–17).

2,845,740; INTEGRAL BARREL LOCK AND EXTRACTOR; Ernest P. Simmons, Kansas City, Kans., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 2, 1954, Serial No. 472,633; 2 Claims. (Cl. 42–75).

2,845,742; COMPOSITE FIREARM BARREL; Harry I. Day, Wellesley, Mass., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application April 27, 1955, Serial No. 504,293; 6 Claims. (Cl. 42–76).

August 12, 1958

2,846,802; GUN SWITCH CONNECTOR; Thomas F. Trefuy, Jamaica, N. Y.; Application November 30, 1956, Serial No. 625,432; 1 Claim. (Cl. 42–84).

2,846,925; AUTOMATIC FIREARM WITH BREECH BLOCK OPERATED DISCONNECTOR; Joseph W. Norman, Springfield, Mass., assignor to Smith and Wesson Inc., Springfield, Mass., a corporation of Massachusetts; Application September 26, 1955, Serial No. 536,487; 3 Claims. (Cl. 89–145).

2,846,926; FLOATING BARREL ACTION FOR AUTOMATIC PISTOL; John W. Kimball, Detroit, Mich.; Application December 14, 1954, Serial No. 475,321; 4 Claims. (Cl. 89–196); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 19, 1958

2,847,784; PRE-STRESSED OPEN-CHAMBER GUN WITH ROTATABLE CYLINDER; David Dardick, Greenwich, Conn., assignor to Dardick Corporation, a corporation of Delaware; Application January 19, 1955, Serial No. 482,905; 4 Claims. (Cl. 42–39.5).

2,847,786; COMPOSITE FIREARM BARREL COMPRISING GLASS FIBERS; James C. Hartley, Branford, Conn., Harry I. Day, Wellesley, Mass., and John L. Wilson, Madison, Conn., assignors to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application February 7, 1955, Serial No. 486,322; 3 Claims. (Cl. 42–76).

2,847,787; FIREARM WITH MOVABLE CHAMBER AND SEALING SLEEVE; David M. Williams, Godwin, N. C., assignor to Olin Mathieson Chemical Corporation, Incorporated, New Haven, Conn., a corporation of Virginia; Application July 5, 1955, Serial No. 520,018; 2 Claims. (Cl. 42–76).

2,847,788; AUTOMATIC SHOTGUN CHOKE; Lester A. Twigg, Bethesda, Md.; Substitute for abandoned application Serial No. 321,810, November 21, 1952. This application October 3, 1955, Serial No. 538,205; 5 Claims. (Cl. 42–79).

2,847,908; AUTOMATIC CHARGER FOR GUNS AND CONTROL THEREFOR; Wayne S. Boals, Los Angeles, Calif., assignor to Hughes Tool Company, Houston, Tex., a corporation of Delaware; Application July 31, 1950, Serial No. 176,877; 22 Claims. (Cl. 89–1).

2,847,909; RIFLE REST; Russell S. Koster, Liawood, Pa.; Application December 20, 1956, Serial No. 629,535; 2 Claims. (Cl. 89–40).

August 26, 1958

2,848,832; **FIRING PIN LOCK ASSEMBLY**; Edward C. Lee, Detroit, Mich., assignor to Ithaca Gun Company, Incorporated, Ithaca, N. Y.; Application April 16, 1954, Serial No. 423,757; 1 Claim. (Cl. 42–70).

2,848,833; **COMBINATION OF LONG-BARRELLED FIREARM AND SAFETY APPENDAGE**; William J. Variey, Springfield, Ohio; Application October 14, 1954, Serial No. 462,247; 2 Claims. (Cl. 42–85).

September 2, 1958

2,849,921; **GATLING GUN**; Harold McCall Otto, decreased, late of Schenectady, N. Y., by the Schenectady Trust Company, executor, Schenectady, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Application April 2, 1954, Serial No. 420,760; 7 Claims. (Cl. 89–12).

2,849,922; **BARREL AND DRUM LOCK**; Anders Petterson, Detroit, Mich., assignor to the United States of America as represented by the Secretary of the Army; Application October 13, 1954, Serial No. 462,130; 4 Claims. (Cl. 89–13).

2,849,923; **GUN BARREL LINER**; Frank D. Cotterman, Lagrange, Ind., assignor to Crane Co., Chicago, Ill., a corporation of Illinois; Application September 30, 1954, Serial No. 459,402; 5 Claims. (Cl. 89–16).

2,849,924; **OSCILLATING FEED TRAY IN A RAMMING DEVICE FOR A GUN**; Robert G. Nutting, Glenview, and Henry M. Pemini, Chicago, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application February 16, 1956, Serial No. 566,054; 4 Claims. (Cl. 89–33).

2,849,925; **RECOIL ADAPTER FOR A GUN**; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 18, 1954, Serial No. 437,901; 2 Claims. (Cl. 89–44); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 9, 1958

2,850,827; **COMBINED SHELL EXTRACTOR AND INDICATOR**; Arthur E. Luciani, Los Angeles, Calif., assignor of ten percent to Brian Wickland, ten percent to Dante V. Luciani, and five percent to Elvira Luciani, all of Hollywood, Calif.; Application August 6, 1956, Serial No. 602,278; 6 Claims. (Cl. 42–1).

2,850,828; **ALUMINUM ALLOY GUN BARREL WITH A LUBRICATING FILM**; George C. Sullivan, Hollywood, Calif.; Application March 24, 1953, Serial No. 344,401; 6 Claims. (Cl. 42–76).

2,850,946; **MUZZLE CLAMP END DEVICE FOR TWIN BARRELED ARTILLERY PIECE**; Joan Francois Scavini, Asnleres, France, assignor to Societe des Forges et Atllers du Creusot, Paris, France; Application April 4, 1956, Serial No. 576,125; 3 Claims. (Cl. 89–14).

2,850,947; **CAM ACTUATED WINGS FOR REVOLVER-TYPE GUNS**; Henry M. Pernini, Chicago, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application November 17, 1954, Serial No. 469,565; 5 Claims. (Cl. 89–155).

September 16, 1958

2,851,809; **BARREL AND REMOVABLE RECEIVER**; Richard H. Colby, South Hadley, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application May 13, 1954, Serial No. 429,707; 4 Claims. (Cl. 42–75); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,851,927; **MACHINE GUNS WITH TWO SECTION FIRING CHAMBERS**; William G. Smith, Studio City, Calif., assignor, by mesne assignments, to Airtek Dynamics, Inc., Los Angeles, Calif., a corporation of California; Application January 27, 1956, Serial No. 561,737; 14 Claims. (Cl. 89–33).

2,851,928; **LOADING MECHANISM FOR A NON-AUTOMATIC GUN**; Karl Sten Rudolf Hultgren, Bofors, and Karl Johan Georg Martensson, Kariskoga, Sweden, assignors to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Application February 14, 1956, Serial No. 565,439; Claims priority, application Sweden February 14, 1955; 3 Claims. (Cl. 89–45).

2,851,929; **PISTOL FIREARM WITH SPRING-RETAINED RECOIL BOLT**; John M. Milroy, Jr., Wilson, Va.; Application October 3, 1955, Serial No. 537,952; 7 Claims. (Cl. 89–194).

September 23, 1958

2,852,880; **SURVIVAL GUN**; Clark E. Kauffman, Leesburg, Fla.; Application November 4, 1955, Serial No. 544,859; 2 Claims. (Cl. 42–2).

2,852,983; **MUZZLE BRAKE**; Paul M. Netzer, Arlington, Va., assignor to the United States of America as represented by the Secretary of the Army; Application December 10, 1952, Serial No. 325,240; 1 Claim. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 30, 1958

2,853,823; **CYLINDER STOP FOR A REVOLVER**; Elijah V. Kirkland, Columbia, S. C.; Application November 12, 1954, Serial No. 468,408; 1 Claim. (Cl. 42–67).

2,853,926; **MULTIPLE GUN MOUNTING AND RECOIL SYSTEM**; Robert E. Miller, Lombard, Ill., assignor to the United States of America as represented by the Secretary of the Air Force; Application December 18, 1956, Serial No. 629,205; 6 Claims. (Cl. 89–37.5).

October 14, 1958

2,855,716; **FIRE CONTROL MECHANISM**; Clark S. Campbell, Ilion, N. Y., assignor to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application April 5, 1955, Serial No. 499,397; 3 Claims. (Cl. 42–69).

2,855,827; **GUN MOUNTS**; Harry Clark Foster, Rosewood Heights, Ill., assignor to Olin Mathieson Chemical Corporation, East Alton, Ill., a corporation of Virginia; Application December 2, 1954, Serial No. 472,631; 3 Claims. (Cl. 89–41).

2,855,828; **RAPID FIRE GUN TURRET APPARATUS**; Phillas H. Girouard, Washington, D. C., Arthur J. Stanton, Bethesda, Carl V. Hickman, Kensington, and David Wertman, Mount Rainler, Md., and Ernest F. Campbell, Springfield, Va.; Application March 31, 1950, Serial No. 153,262; 32 Claims. (Cl. 89–45); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 21, 1958

2,856,716; **AUTOMATIC RIFLE WITH A COMBINED MOVABLE CHAMBER AND MAGAZINE**; Robert Compton, Odem, Tex.; Application January 18, 1957, Serial No. 634,968; 1 Claim. (Cl. 42–39.5).

2,856,717; **RIFLE TRIGGER AND SAFETY MECHANISM**; William R. Parke, Union Gap, Wash.; Application April 1, 1957, Serial No. 650,010; 5 Claims. (Cl. 42–69).

2,856,718; **SAFETY MECHANISM FOR FIREARMS**; Joseph F. Fischer, Grand Rapids, Mich.; Application June 24, 1957, Serial No. 667,405; 14 Claims. (Cl. 42–70).

2,856,719; **GAS-OPERATED, SPRING-ROTATED, AUTOMATIC CHOKE DEVICE FOR SHOTGUNS**; Haskell E. Metz, Marion, Ohio; Application June 16, 1955, Serial No. 515,899; 1 Claim. (Cl. 42–79).

2,856,720; **MAGAZINE CHARGER FOR A FIREARM**; William R. Kunz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application August 14, 1956, Serial No. 604,050; 1 Claim. (Cl. 42–87); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,856,821; **SEAR DEVICE FOR A FIREARM**; Edward C. Lee, Detroit, Mich., assignor to the United States of America as represented by the Secretary of the Army; Application November 25, 1953, Serial No. 394,523; 1 Claim. (Cl. 89–136).

October 28, 1958

2,857,700; **CAM CONTROL OVER EXTRACTOR**; Otto H. von Lossnitzer, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application December 12, 1955, Serial No. 552,670; 2 Claims. (Cl. 42–68); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,857,701; **ADJUSTABLE FORE-END REST FOR TARGET RIFLES**; Cyrus G. Morrison, Fort Edward, N. Y.; Application 13, 1957, Serial No. 683,910; 2 Claims. (Cl. 42–85).

2,857,812; **GUN HAVING ARTILLERY TRAINING ROUND OF AMMUNITION**; William G. Nichols, Los Angeles, Calif., assignor to the United States of America as represented by the Secretary of the Army; Application March 2, 1956, Serial No. 569,211; 6 Claims. (Cl. 89–29); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,857,813; **PNEUMATIC CARTRIDGE FEEDER**; Harry E. Elliott, Venice, Calif.; assginor to Hughes Tool Company, Houston, Texas, a corporation of Delaware; Application April 27, 1953; Serial Number 351,427; 10 Claims. (Cl. 89–33).

2,857,814; **FEEDING MECHANISM FOR A FIREARM**; Cecil H. Taylor, New Milford, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application April 4, 1956, Serial No. 576,223; 6 Claims. (Cl. 89–33).

2,857,815; **EQUILIBRATOR SYSTEM FOR A VEHICLE MOUNTED GUN**; Roland A. Magnuson, Seattle, Wash., assignor to the United States of America as represented by the Secretary of the Army; Application January 11, 1957, Serial No. 633,808; 12 Claims. (Cl. 89–37).

2,857,816; **AUTO-COLLIMATED STEREOSCOPIC RANGE FINDER INCORPORATING A BALLISTIC COMPUTING MECHANISM**; Clayton T. Deal, Abington, and Francis B. Patrick, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Application July 23, 1956, Serial No. 599,666; 15 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

November 4, 1958

2,858,738; **GUN BARREL DETACHING AND RETAINING DEVICE**; Ralph E. Armbruster, Alexandria, and Charles W. Sherertz, Arlington, Va., assignors to the United States of America as represented by the Secretary of the Navy; Application July 29, 1957, Serial No. 674,987; 6 Claims. (Cl. 89–14.1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,858,739; **HYDRAULIC FEEDING MECHANISM FOR A FIREARM**; James O. Eames, Washington, Conn., assignor to the United States of America as represented by the Secretary of the Army; Application August 17, 1956, Serial No. 604,855; 4 Claims. (Cl. 89–33).

2,858,740; **GUN CARRIAGE ROTATABLE THROUGH 360 DEGREES**; Michael G. Harring, Silver Hill, Md., and Nathan S. Glassman, Falls Church, Va.; Application August 1, 1952, Serial No. 302,282; 20 Claims. (Cl. 89–40); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,858,741; **SELECTIVE FIRING CONTROL FOR OPEN AND CLOSED BOLT POSITIONS**; Clarence E. Simpson, Wilbraham, Mass.; Application July 11, 1956, Serial No. 597,311; 5 Claims. (Cl. 89–140); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,858,742; **ACTUATOR TONGUE SWITCH FOR AN AUTOMATIC FIREARM**; John F. O'Brien, Jr., Springfield, Mass., assignor Serial No. 390,766; 3 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

November 11, 1958

2,859,664; **DRUM COOLING DEVICE**; William P. Murphy, West Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 15, 1956, Serial No. 591,771; 3 Claims. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

November 25, 1958

2,861,374; **SLIDE BOLT ACTION FOR FIREARMS**; Samuel L. Hampton, La Mesa, Calif.; Application February 1, 1957, Serial No. 637,790; 2 Claims. (Cl. 42–16).

2,861,375; **CHOKE DEVICE FOR ATTACHMENT TO A SHOTGUN**; Douglas S. Rodick, South Portland, Maine; Application December 30, 1955, Serial No. 556,658; 2 Claims. (Cl. 42–79).

2,861,376; **INERTIA OPERATED CHOKE FOR SHOTGUNS**; Louis M. Denaux, Charleston, S. C.; Application May 21, 1957, Serial No. 660,567; 9 Claims. (Cl. 42–79).

December 2, 1958

2,862,324; **CLIP-SLIDE DEPRESSOR**; Albert L. Ball, Worcester, Mass.; Application August 4, 1955, Serial No. 526,475; 1 Claim. (Cl. 42–50).

December 9, 1958

2,863,246; **BOLT ASSEMBLY FOR A FIREARM**; Edward C. Lee, Detroit, Mich., assignor to Ithaca Gun Company, Incorporated, Ithaca, N. Y.; Application April 16, 1954, Serial No. 423,553; 1 Claim. (Cl. 42–16).

2,863,247; **SLIDE-ACTION FIREARM WITH HAMMER RELEASABLE ACTION LOCK**; Carl H. Benson, New Haven, Conn., assignor to O. F. Mossberg & Sons, Inc., New Haven, Conn., a corporation of Connecticut; Application August 31, 1955, Serial No. 531,798; 8 Claims. (Cl. 42–20).

2,863,248; **REMOVABLE CYLINDER SPINDLE OF CYLINDER REVOLVERS**; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia, assignors to Konstrukta Praha, narodni podnik, Pragud, Czechoslovakia; Application October 17, 1956, Serial No. 616,409; 2 Claims. (Cl. 42–59).

2,863,249; **SAFETY FOR REVOLVERS**; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia, assignors to Knostrukta Praha, narodni podnik, Prague, Czechoslovakia; Application October 17, 1956, Serial No. 616,411; 2 Claims. (Cl. 42–66).

2,863,359; **FIRE CONTROL MECHANISM FOR AUTOMATIC FIREARMS**; William R. Kunz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application July 25, 1957, Serial No. 674,264; 4 Claims. (Cl. 89–131); (Granted under Title 35, U.S. Code (1952), sec. 266).

December 16, 1958

2,864,193; **HOLDERS FOR MAGAZINES**; Harold S. Drew, Sanford, Mich.; Application March 23, 1956, Serial No. 573,531; 2 Claims. (Cl. 42–1).

2,864,194; **MANUALLY AND AUTOMATICALLY ADUSTABLE CHOKE FOR SHOTGUNS**; Arne Y. Grahn, Hartford, Conn., assignor to The Poly Choke Company, Incorporated, East Hartford, Conn., a corporation of Connecticut; Application September 17, 1957, Serial No. 684,583; 10 Claims. (Cl. 42–79).

December 23, 1958

2,865,126; **OPEN CHAMBER GUN**; David Dardick, Greenwich, Conn., assignor to Dardick Corporation, a corporation of Delaware; Application September 3, 1954, Serial No. 454,045; 12 Claims. (Cl. 42–60).

2,865,127; **TRIGGER FINGER REST FOR FIREARMS**; Thomas J. Finnegan, Los Angeles, Calif., assignor of one-half to Robert Swan, Los Angeles, Calif.; Application September 12, 1955, Serial No. 533,731; 4 Claims. (Cl. 42–69).

2,865,254; **RECOILING BARREL OPERATED PIVOTED LOADING TRAY MECHANISM**; Henry Wilhelm Aldrin, Bofors, Sweden, assignor to Aktiebolag Bofors, Bofors, Sweden, a corporation of Sweden; Application September 17, 1954, Serial No. 456,664; Claims priority, application Sweden October 1, 1953; 3 Claims. (Cl. 89–45).

2,865,255; **FIREARM WITH TRANSVERSELY MOVABLE BARREL CHAMBER**; Roger Marsh, Hudson, Ohio, assignor to Weapons, Inc., Hudson, Ohio, a corporation of Ohio; Application August 3, 1955, Serial No. 526,172; 19 Claims. (Cl. 89–163).

2,865,256; **COMPENSATING DEVICE FOR FIREARMS**; Roger Marsh, Hudson, Ohio, assignor to Weapons, Inc., Hudson, Ohio, a corporation of Ohio; Application October 13, 1954, Serial No. 461,999; 2 Claims. (Cl. 89–191).

December 30, 1958

2,866,288; **BALL BEARING AND RETAINING BAND LOCKING DEVICE FOR THE OUTER SLEEVE OF ADJUSTABLE CHOKES**; George L. Herter, Waseca, Minn:; assignor to Herter's, Inc.; Waseca, Minn.; a corporation of Minnesota; Application September 15, 1952; Serial Number 309,621; 1 Claim. (Cl. 42–79).

2,866,289; **UNLOADING ATTACHMENT FOR RIFLES**; Leslie L. Wilcox, Long Beach, N. J.; Application July 19, 1955, Serial No. 523,022; 4 Claims. (Cl. 42–87).

2,866,384; **COMBINATION OF HEDGEHOG PROJECTOR AND GUN MOUNT**; Sidney Hersh, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy; Application April 16, 1953, Serial No. 349,330; 3 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,866,386; **DESIGN FOR GUNS EMPLOYING SPLIT CHAMBER**; Victor F. Lucht, Arlington County, Va., assignor to the United States of America as represented by the Secretary of the Army; Application May 1, 1956, Serial No. 582,053; 3 Claims. (Cl. 89–13); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,866,387; **BREECH BLOCK MECHANISM**; Rudolph E. Stern, Chicago, Ill., and Rufus D. Kelser, Stamford, Conn., assignors to the United States of America as represented by the Secretary of the Army; Application January 11, 1957, Serial No. 633,809; 3 Claims. (Cl. 89–17).

2,866,388; **AMMUNITION BELT CONNECTOR AND DISINTEGRATOR**; William E. Reynolds, Riverside, and Vito A. Fusco, Chicago, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application September 11, 1956, Serial No. 609,332; 3 Claims. (Cl. 89–35).

2,866,389; **BUFFER MECHANISM**; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application June 4, 1954, Serial No. 444,440; 2 Claims. (Cl. 89–198).

January 13, 1959

2,867,930; THUMB-OPERATED TRIGGER SAFETY; Casimer M. Niesp, Buffalo, N.Y.; Application January 23, 1956; Serial No. 560,662; 2 Claims; (Cl. 42–70)

2,867,931; GUN BARREL AND GUN STOCK ASSEMBLY; Everett R. Schreiber; Maywood, Ill.; Application August 17, 1955; Serial No. 529,019; 7 Claims; (Cl. 42–75).

2,867,932; AUTOMATIC CHOKE FOR SHOTGUNS; George M. Keightley; Wichita, Kans; a corporation of Kansas; Application January 23, 1956; Serial No. 560,493; 10 Claims; (Cl. 42–79)

2,868,078; NOISE REDUCER FOR GUN; William J. Jarrett; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application January 11, 1956; Serial No. 558,593; 1 Claim; (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,868,079; MACHINE GUN COOLING SYSTEM; George A. Hawkins; Lafayette, Ind.; assignor to Purdue University; Lafayette, Ind.; Application December 19, 1947; Serial No. 792,722; 19 Claims; (Cl. 89–14).

2,868,080; GUN MOUNT ASSEMBLY; Edward J. Meyer; Normandy, Mo.; Application January 5, 1956; Serial No. 557,554; 4 Claims; (Cl. 89–37).

2,868,081; RETRACTABLE FIRING PIN; Donald P. Grover; Chicago, Ill.; assignor, by mesne assignments to the United States of America as represented by the Secretary of the Army; Application August 29, 1956; Serial No. 606,940; 2 Claims; (Cl. 89–135).

2,868,082; DROP LOCK BOLT FOR GUN; Robert G. Nutting, Glenview, and Robert F. Windstrup, Chicago, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application October 13, 1955, Serial No. 540,362; 3 Claims. (Cl. 89–190).

2,868,083; PREFABRICATED GUN RECEIVER; Robert F. Windstrup, Chicago, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application September 21, 1955, Serial No. 535,775; 2 Claims. (Cl. 89–199).

January 20, 1959

2,869,268; SPRING EJECTOR MEANS; Harry H. Sefried II and Erik J. Gunnesson, New Haven, Conn., assignors of one-half to Sears, Roebuck and Co., Chicago, Ill., a corporation of Illinois, and one-half to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut; Application September 7, 1955, Serial No. 532,848; 7 Claims. (Cl. 42–25).

2,869,269; SAFETY MECHANISM FOR FIREARMS; Wilfried J. Couture, deceased, late of New Haven, Conn., by Clara M. Couture, administratrix, New Haven, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation; Application June 2, 1955, Serial No. 512,606; 1 Claim. (Cl. 42–70).

2,869,270; SHOTGUN CHAMBER WITH CUTTING EDGE; Ernest P. Simmons, Kansas City, Kans.; Application April 3, 1957, Serial No. 650,413; 6 Claims. (Cl. 42–76).

2,869,271; REMOVABLE VENTILATED RIB FOR SHOTGUNS; Richard J. Berg, Milwaukee, Wis.; Application June 21, 1957, Serial No. 667,135; 1 Claim. (Cl. 42–76).

2,869,272; GAS-OPERATED AUTOMATIC SHOTGUN CHOKE; Eugene F. Coyle, Hartford, S. Dak.; Application July 18, 1956, Serial No. 598,674; 4 Claims. (Cl. 42–79).

January 27, 1959

2,870,561; CARTRIDGE POSITIONER; Richard H. Colby, South Hadley, Mass., assignor to the United States of America, as represented by the Secretary of the Army; Application May 15, 1956, Serial No. 585,127; 1 Claim. (Cl. 42–18).

2,870,562; CARTRIDGE CASE EXTRACTOR FOR A FIREARM; John W. Kimball, Detroit, Mich.; Application February 8, 1956, Serial No. 564,331; 3 Claims. (Cl. 42–25); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,870,679; FLASH SUPPRESSOR; Richard V. Collins, Dahlgren, Va., assignor to the United States of America as represented by the Secretary of the Army; Application November 25, 1952, Serial No. 322,468; 10 Claims. (Cl. 89–14).

2,870,680; DEVICE FOR THE CONTROL OF THE BREECH OF A DOUBLE-BARRELLED GUN; Henri Correc, Paris, France, assignor to Societe des Foreges et Ateliers du Creusot, Paris, France; Application January 31, 1956, Serial No. 562,564; Claims priority, application France February 3, 1955; 9 Claims. (Cl. 89–17).

2,870,681; CONTAINER FOR A CARTRIDGE BELT; Johannes Linke, Zurich, Switzerland, assignor to Machine Tool Works, Oerlikon, Administration Company, Zuirch-Oerlikon, Switzerland, a company of Switzerland; Application May 26, 1958, Serial No. 737,910; Claims priority, application Switzerland June 18, 1957; 2 Claims. (Cl. 89–34).

2,870,682; CARTRIDGE RAM LINK; Charles R. Bell, Canoga Park, Calif., and Eugene S. Wassel, La Grange, and Mitchell Jay Shoelson, Hometown, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application October 7, 1957, Serial No. 688,787; 2 Claims. (Cl. 89–35).

2,870,683; **ADJUSTABLE TRIPOD TYPE GUN MOUNT**; Walter H. Wilson, Mansfield, Ohio; Application September 20, 1955, Serial No. 535,416; 6 Claims. (Cl. 89–40).

2,870,684; **TURBINE ENGINE BLOW-OUT PREVENTER**; Clarence L. Johnson, Encino, Calif., assignor to Lockheed Aircraft Corporation, Burbank, Calif.; Application December 28, 1953, Serial No. 400,463; 10 Claims. (Cl. 89–133).

2,870,685; **GAS-OPERATED ACTUATING SYSTEM FOR FIREARMS**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application February 21, 1957, Serial No. 641,784; 2 Claims. (Cl. 89–191); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 3, 1959

2,871,603; **CUT-OFF DEVICE FOR A MAGAZINE FIREARM**; Rolf H. Wild, Hamden, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application February 21, 1958, Serial No. 716,639; 5 Claims. (Cl. 42–17).

2,871,604; **ADJUSTABLE TRIGGER SPRING**; Joseph W. Norman, Springfield, Mass., assignor to Smith and Wesson, Inc., Springfield, Mass., a corporation of Massachusetts; Application May 28, 1957, Serial No. 662, 194; 7 Claims. (Cl. 42–69).

2,871,605; **SAFETY GUN TRIGGER**; Elmer A. Anderson, Moorhead, Minn.; Application March 26, 1957, Serial No. 648,696; 1 Claim. (Cl. 42–70).

2,871,606; **SEAR SAFETY OPERATED BY LOADING COVER AND BREECH BOLT**; Wallace B. Butler, Branford, and Frank A. Prybyla and James J. Reardon, Hamden, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application August 2, 1957, Serial No. 675,908; 7 Claims. (Cl. 42–70).

February 10, 1959

2,872,846; **HIGH VELOCITY GUN**; William D. Crozier, Socorro, N. Mex., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Application July 7, 1954, Serial No. 441,962; 5 Claims. (Cl. 89–7).

2,872,847; **MULTIBARREL GUN WITH SKEWED BORE AXES**; Harold M. Otto, deceased, late of Schenectady, N. Y., by Schenectady Trust Company, executor, Schenectady, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Application August 18, 1954, Serial No. 450,827; 6 Claims. (Cl. 89–12).

2,872,848; **GUN BLAST SUPPRESSOR**; Karl E. Schuessler, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of the Navy; Application December 1, 1954, Serial No. 472,537; 3 Claims. (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,872,849; **CLOSED AND OPEN FIRE CONTROL MECHANISM**; Clarence E. Simpson, Wilbraham, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application July 11, 1956, Serial No. 597,310, 5 Claims. (Cl. 89–140); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,872,850; **SUB-CALIBER MECHANISM INCLUDING A MOVABLE SUB-CALIBER BARREL**; Ross G. Davenport, Rochester, N. Y.; Application June 27, 1955, Serial No. 518,153; 2 Claims. (Cl. 89–159).

2,872,851; **DOUBLE EXPANSION BALL FLOAT GAS SYSTEM FOR A FIREARM**; David L. Katz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application May 16, 1957, Serial No. 659,738; 1 Claim. (Cl. 89–193); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 17, 1959

2,873,546; **FIREARM**; Harold D. Allyn, Springfield, Mass.; Application June 25, 1957, Serial No. 667,892; 8 Claims. (Cl. 42–25).

2,873,648; **REMOTE CONTROL FLUID PRESSURE RESPONSIVE ACTUATOR**; C Walton Musser and Francis W. Dietsch, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Application May 7, 1953, Serial No. 353,702; 2 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,873,649; **FEED DEVICES FOR AUTOMATIC GUNS SUPPLIED WITH AMMUNITION IN THE FORM OF A CARTRIDGE BELT**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S. A., Geneva, Switzerland, a Swiss society; Application December 9, 1955, Serial No. 552,133; Claims priority, application Luxembourg December 16, 1954; 8 Claims. (Cl. 89–33).

2,873,650;**FLUID TRANSFER RATE CONTROL FOR A FIRING MECHANISM** ; Harry E. Pinkerton, Jr., Oyster Bay, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Application May 24, 1957, Serial No. 661,550; 3 Claims. (Cl. 89–131).

2,873,651; **RECOIL SELECTOR MECHANISM FOR FIREARMS**; Ralph D. Lambert, St. Louis, Mo.; Application July 22, 1955, Serial No. 523,768; 12 Claims. (Cl. 89–198).

February 24, 1959

2,874,501; SIGHT FOR REPEATING SMALL ARMS; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia, assignors to Konstrukta Praha, narodni podnik, Prague, Czechoslovakia; Application October 17, 1956, Serial No. 616,410; 4 Claims. (Cl. 42–1).

2,874,502; GRIP AND TRIGGER ARRANGEMENT FOR HAND FIREARMS; Thomas W. Lockwood, Berwyn, Ill.; Application March 29, 1957, Serial No. 649,390; 1 Claim. (Cl. 42–69).

2,874,503; TRIGGER SAFETY DEVICE FOR GUNS; Casimir M. Niesp, Buffalo, N.Y.; Application April 12, 1957, Serial No. 652,619; 5 Claims. (Cl. 42–70).

2,874,504; SHOT GUN RIB SIGHT; George A. Martinek, Cleveland, Ohio; Application February 24, 1956, Serial No. 567,683; 7 Claims. (Cl. 42–76).

2,874,614; RECOILLESS GUN HAVING RADIALLY MOVABLE BREECH SECTORS; C Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Original application February 11, 1952, Serial No. 271,056, now Patent No. 2,791,961, dated May 14, 1957. Divided and this application January 14, 1957, Serial No. 634,128; 3 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,874,615; AMMUNITION STORAGE BOX; Ormund A. Kravik, White Bear Lake, Minn., assignor to Nobles Engineering Company, St. Paul, Minn., a corporation of Minnesota; Application March 28, 1955, Serial No. 497,129; 6 Claims. (Cl. 89–34).

March 3, 1959

2,875,544; FIREARM CARTRIDGE MAGAZINE; Robert R. Krieger, Mount Clemens, Mich.; Application January 3, 1955, Serial No. 479,332; 7 Claims. (Cl. 42–18).

2,875,545; REVOLVER COCKING MECHANISM ACTUATED BY SIDE LEVER; Edward I. Westmoreland, Plymouth, Mass.; Application August 13, 1956, Serial No. 603,562; 8 Claims. (Cl. 42–65).

2,875,671; AMMUNITION BELT FEED SYSTEM FOR AUTOMATIC FIREARMS; Russell S. Robinson, Short Beach, Conn.; Application August 6, 1953, Serial No. 372,731; 16 Claims. (Cl. 89–33).

March 10, 1959

2,876,576; BREECH RELEASE MECHANISM; Lester F. Mulno, Worcester, Mass., assignor to Harrington & Richardson, Inc., Worcester, Mass., a corporation of Massachusetts; Application May 13, 1958, Serial No. 734,961; 9 Claims. (Cl. 42–44).

2,876,679; BIAS MECHANISM FOR MATCHING THE TRAJECTORIES OF GUNS; Frank W. Dietsch, Levittown, Pa., and C Walton Musser, Beverly, Mass., assignors to the United States of America as represented by the Secretary of the Army; Application December 12, 1957, Serial No. 702,489; 3 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,876,680; PIVOTALLY MOUNTED OSCILLATING BREECH MEMBER COUPLED WITH A RAMACTOR MECHANISM; Arthur R. Meyer and John F. O'Brien, Springfield, Mass., assignors to the United States of America as represented by the Secretary of the Army; Application June 28, 1955, Serial No. 518,699; 4 Claims. (Cl. 89–156); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,876,681; FIRST ROUND RECOIL REDUCER FOR AUTOMATIC GUNS; Karl W. Maier, Torrance, Calif., assignor to Northrop Aircraft, Inc., Hawthorne, Calif., a corporation of California; Application June 7, 1956, Serial No. 589,971; 8 Claims. (Cl. 89–198).

March 17, 1959

2,877,590; MAGAZINE INERTIA LATCH; Charles Harry Morse, Herkimer, N. Y., assignor to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Application December 18, 1956, Serial No. 629,146; 11 Claims. (Cl. 42–6).

2,877,689; STAND FOR PISTOLS; Herman K. Pribis, Scotia, N. Y.; Application May 4, 1954, Serial No. 427,443; 1 Claim. (Cl. 89–37).

2,877,690; COUNTER RECOIL GOVERNOR FOR A RECOIL TYPE GUN; Irwin R. Barr, Kingsville, and David D. Terwilliger, Baltimore, Md., assignors to Aircraft Armaments, Inc., Baltimore, Md., a corporation of Maryland; Application November 25, 1953, Serial No. 394,320; 6 Claims. (Cl. 89–43).

March 31, 1959

2,879,694; **SUPPORTING MEANS AND RECOIL SPRING FOR A GUN MOUNT**; Harry Clark Foster, Rosewood Heights, Ill., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application December 28, 1953, Serial No. 400,431; 2 Claims. (Cl. 89—44).

April 7, 1959

2,880,543; **PISTOL**; Peter von Frantzius, Chicago, Ill., assignor to Hercules Gas-Munitions Corporation, Chicago, Ill., a corporation of Illinois; Application June 26, 1956, Serial No. 593,973; 3 Claims. (Cl. 42—1).

April 14, 1959

2,881,547; **MULTI-PART BREECH BOLT MECHANISM**; Wallace B. Butler, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application July 29, 1955, Serial No. 525,136; 2 Claims. (Cl. 42—16).

2,881,664; **MAIN BATTERY MULTIPLE GUN TURRET SIGHT MECHANISM**; George A. Chadwick, Detroit, Mich., and Phillias H. Girouard, Washington, D. C., assignors to the United States of America as represented by the Secretary of the Navy; Application July 27, 1944, Serial No. 546,896; 2 Claims. (Cl. 89—41); (Granted under Title 35, U.S. Code (1952) sec. 266).

April 21, 1959

2,882,634; **DETENT**; Nestor F. Smith, Ithaca, N. Y., assignor to Ithaca Gun Company, Incorporated, Ithaca, N. Y., a corporation of New York; Application March 28, 1956, Serial No. 574,119; 1 Claim. (Cl. 42—16).

2,882,635; **TUBULAR COMBINED CARTRIDGE CONTAINER AND MAGAZINE UNIT**; John L. Hill, Houston, Tex.; Application December 19, 1956, Serial No. 629,354; 8 Claims. (Cl. 42—17).

2,882,636; **SAFETY CAP FOR TRIGGER GUARDS FOR FIREARMS**; Lawrence P. Shinaver, Mount Clemens, Mich.; Application November 30, 1956, Serial No. 625,481; 3 Claims. (Cl. 42—70).

2,882,794; **ELECTRICALLY FIRED GUN CHARGER**; George H. Bornheim and Herve J. Ouellette, Springfield, Mass., assignors to the United States of America as represented by the Secretary of the Army; Application March 20, 1957, Serial No. 647,456; 3 Claims. (Cl. 89—1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,882,796; **HYPERVELOCITY GUN**; Austin B. J. Clark, Oxon Hill, and Paul T. Boltz, Potomac Heights, Md.; Application February 15, 1957, Serial No. 640,564; 7 Claims. (Cl. 89—7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,882,797; **QUICK DETACHABLE CONNECTION BETWEEN A GUN AND ITS MOUNT**; C Walton Musser, Levittown, Pa., assignor to the United States of America as represented by the Secretary of the Army; Application March 9, 1956, Serial No. 570,648; 3 Claims. (Cl. 89—27); (Granted under Title 35, U.S. Code (1952), sec. 266).

April 28, 1959

2,883,781; **COMBINATION STABILIZER, RECOIL BRAKE, FLASH HIDER, AND GRENADE LAUNCHER FOR A FIREARM**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application October 23, 1957, Serial No. 692,014; 1 Claim. (Cl. 42—1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,883,782; **AUTOMATIC SHOTGUN CHOKE**; Ario E. Schroeder, Newton, Kans.; Application January 25, 1956, Serial No. 561,263; 5 Claims. (Cl. 42—79).

2,883,911; **MACHINE GUN**; Daniel D. Musgrave, Cabin John Park, Md.; Application March 5, 1956, Serial No. 569,510; 1 Claim. (Cl. 89—161).

May 5, 1959

2,884,837; **LIGHTWEIGHT RECOILLESS GUN**; Leo Shapiro and Andrew D. St. John, Prairie Village, Kans., assignors to the United States of America as represented by the Secretary of the Army; Application December 12, 1956, Serial No. 627,969; 2 Claims. (Cl. 89—1.7).

May 12, 1959

2,885,811; **FOLLOWER LATCH FOR CARTRIDGE MAGAZINES**; Sherman C. Womble, Jr., Fair Oaks, Calif.; Application April 25, 1958, Serial No. 730,900; 9 Claims. (Cl. 42—50).

2,885,812; **GUN SUPPORTING SLINGS**; Leon G. Arpin, North Caldwell, N. J.; Application October 19, 1956, Serial No. 617,093; 3 Claims. (Cl. 42–85).

May 19, 1959

2,887,011; **FUSE SETTER COMBINED WITH LOADING MECHANISM**; Valentine Pearce Harvey and Frank Parry, Deptford, London, England, assignors to Molins Machine Company, Limited, London, England; Application May 24, 1945, Serial No. 595,538; 11 Claims. (Cl. 89–6.5).

2,887,012; **FIRING MECHANISM FOR AN AUTOMATIC FIREARM**; William R. Kunz, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application August 21, 1957, Serial No. 679,802; 5 Claims. (Cl. 89–131); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,887,013; **COMPENSATING DEVICE USED WITH DIFFERENT SIZED CARTRIDGES**; Roger Marsh, Hudson, Ohio, assignor to Weapons, Inc., Hudson, Ohio, a corporation of Ohio; Application March 16, 1955, Serial No. 494,754; 1 Claim. (Cl. 89–193).

May 26, 1959

2,887,808; **FIREARMS CARRIER MECHANISM**; Stefan K. Janson, New Haven, Rolf H. Wild, Hamden, and Howard E. Elliott, Cheshire, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application April 24, 1957, Serial No. 654,857; 3 Claims. (Cl. 42–17).

2,887,810; FIREARM BARREL LATCH; Joseph W. Norman, Springfield, Mass., assignor to Smith and Wesson, Inc., Springfield, Mass., a corporation of Massachusetts; Application May 28, 1957, Serial No. 662,170; 1 Claim. (Cl. 42–75).

2,887,811; **CARTRIDGE CLIP FOR LOADING BOX MAGAZINES**; Melvin M. Johnson, Jr., New Haven, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application June 9, 1955, Serial No. 514,353; 7 Claims. (Cl. 42–87).

2,887,931; **DRUM ACTUATING CAM FOR REVOLVER-TYPE GUN**; Ewald A. Kamp, Chicago, and Eugene S. Wassel, Cicero, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application December 15, 1954, Serial No. 475,593; 4 Claims. (Cl. 89–155).

2,887,932; **CONTROL DEVICE**; Erich Billig, St. Gallen, Switzerland, assignor to Starrfrasmaschinen AG., Rorschacherberg, Switzerland, a Swiss company; Application April 5, 1956, Serial No. 576,301; Claims priority, application Switzerland April 15, 1955; 3 Claims. (Cl. 90–62).

June 2, 1959

2,888,769; **CHOKE MECHANISM FOR FIREARMS**; Arne Y. Grahn, Hartford, Conn.; Application April 26, 1956, Serial No. 580,739; 8 Claims. (Cl. 42–79).

June 9, 1959

2,889,653; **FIRING MECHANISM**; Herbert C. Clauser and Robert S. Long; Westerville, Ohio; a corporation of Ohio; Original application July 29, 1952; Serial No. 301,524; now Patent No. 2,785,632; dated March 19, 1957; Divided and this application November 7, 1956; Serial No. 620,871; 2 Claims; (Cl. 42–1)

2,889,654; **SKIRTED BALL JOINT SEAL FOR A FIREARM DRUM**; Clifford E. La Fever; Dearborn, Mich.; assignor to the United States of America as represented by the Secretary of the Army; Application July 9, 1957; Serial No. 670,834; 4 Claims (Cl. 42–59)

2,889,747; **RECOILLESS GUN FOR SEPARATE LOADING AMMUNITION**; Ewald A. Kamp; Chicago; and Richard W. Roberts; Lombard, Ill.; assignors to the United States of America as represented by the Secretary of the Army; Application October 30, 1956; Serial No. 619,370; 1 Claim; (Cl. 89–1.7)

2,889,748; **OBTURATING MEANS FOR A FIREARM**; Earle M. Harvey, Agawam, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application November 7, 1957; Serial No. 695,181; 2 Claims; (Cl. 89–26); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,889,749; **SPROCKET TYPE FEEDING FOR A GAS PISTON GUN**; Stefan Kenneth Janson; New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; New Haven, Conn.; a corporation of Virginia; Application July 2, 1956; Serial No. 595,522; 11 Claims; (Cl. 89–33).

2,889,750; **CAM ACTUATED ROUND DEFLECTOR**; Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application May 17, 1956; Serial No. 585,592; 1 Claim; (Cl. 89–33) (Granted under Title 35, U.S. Code (1952), sec. 266).

2,889,751; AMMUNITION MAGAZINE; Andrew G. Bilek; Valparaiso, Fla.; assignor to the United States of America as represented by the Secretary of the Air Force; Application May 21, 1957; Serial No. 660,724; 3 Claims; (Cl. 89–34); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,889,752; LATCH TYPE AIRCRAFT GUN MOUNT; Edward J. Meyer; Normandy, No.; assignor to North American Aviation, Inc.; Application December 31, 1956; Serial No. 631,592; 6 Claims (Cl. 89–37.5).

2,889,753; BARREL POSITIONER FOR AUTOMATIC PISTOL; George W. Whitney; Tulsa, Okla.; Application May 9, 1958; Serial No. 734,284; 5 Claims; (Cl. 89–160).

June 16, 1959

2,890,625; PRE–ENGRAVED PROJECTILES AND GUN FOR FIRING SAME; Frank R. Simpson, Upper Darby, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Original application June 14, 1951; Serial No. 231,493; now Patent No. 2,804,806; dated September 3, 1957; Divided and this application March 29, 1957; Serial No. 652,641; 1 Claim. (Cl. 89–34).

2,890,626; LOCKING MEMBERS FOR A COMPOSITE BREECH BLOCK; Rudolf Amsler; Neuhausen am Rheinfall, Switzerland; assignor to Schweizerische Industrie-Gesellschaft, Neuhausen am Rheinfall, Switzerland; Application May 10, 1956; Serial No. 584,007; Claims priority; application Switzerland May 13, 1955; 5 Claims. (Cl. 89–180)

June 23, 1959

2,891,341; SECURING MEANS FOR FORE–END OF AUTOLOADING FIREARM; Lexir Ray Crittendon, Wilmington, Del.; Ellis William Hailston, Ilion, N.Y.; Phillip Richard Haskell, Fairfield, Conn.; and Robert Peter Kelly and Wayne Edwin Leek, Ilion, N.Y.; Original application May 2, 1956; Serial No. 582,153; Divided and this application September 20, 1957; Serial No. 685,304; 4 Claims. (Cl. 42–75).

2,891,448; FEEDING INSTALLATION FOR FEEDING ROUNDS OF AMMUNITION FROM A MAGAZINE TO A HOIST; Sten August Henstrom and Karl Sten Rudolg Hultgren; Bofors, Sweden; assignors to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Application February 25, 1957; Serial No. 642,200; Claims priority, application Sweden February 22, 1956; 13 Claims; (Cl. 89–46).

2,891,449; GUN CONTROL CIRCUIT FOR SEMI–AUTOMATIC OPERATION OF MACHINE GUN; Murray W. Bair; Fort Wayne, Ind.; assignor to The Magnavox Company; Fort Wayne, Ind.; a corporation; Application August 22, 1955; Serial No. 529,785; 3 Claims; (Cl. 89–135).

June 30, 1959

2,892,384; TILT CORRECTOR FOR A GUN MOUNTING; John Reginald Kelly; London, England; a British company; application June 17, 1954; Serial No. 437,329; Claims priority; application Great Britain July 14, 1953; 14 Claims (Cl. 89–41).

2,892,385; CARTRIDGE POSITIONING CAM FOR AUTOMATIC REVOLVER GUNS; John L. MacDonald, Chicago, Ill.; assignor, by mesne assignments to the United States of America as represented by the Secretary of the Army; Application August 29, 1956; Serial No. 606,939; 1 Claim; (Cl. 89–137).

July 7, 1959

2,893,153; ADJUSTABLE BARREL AND RECEIVER CONNECTION; Ellis William Hallston and Harold L. Hameister, Ilion, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Original application January 19, 1955; Serial No. 482,726; now Patent No. 2,751,702; dated June 26, 1956; Divided and this application February 8, 1956; Serial No. 564,248; 2 Claims; (Cl. 42–75).

July 14, 1959

2,894,346; FIRING MECHANISM WITH A SINGLE SPRING FOR THE HAMMER, HAMMER CATCH MEANS AND TRIGGER; Walter H.B. Smith, New York, N.Y.; Application April 5, 1956; Serial No. 576,275; 13 Claims; (Cl. 42)69).

2,894,347; FLUID CYLINDER SURROUNDING A STATIONARY BARREL; Francis Henry Woodcock; Gloucester, England; Application June 22, 1956; Serial No. 593,050; Claims priority; application Great Britain June 25, 1955; 3 Claims; (Cl. 42–75).

2,894,349; **AUTOMATIC CHOKE DEVICE FOR SHOTGUNS**; Robert G. Hare; Sharon, Mass.; assignor to Hartford Gun Choke Company, Inc.; Newington, Conn.; a corporation of Connecticut; Application November 9, 1955; Serial No. 545,931; 7 Claims; (Cl. 42–79).

2,894,350; **STRIP CLIP FOR LOADING BOX MAGAZINES**; Stefan Kenneth Janson; New Haven, Conn.; assigonr to Olin Mathieson Chemical Corporation, New Haven, Conn.; a corporation of Virginia; Application April 11, 1956; Serial No. 577,482; 4 Claims; (Cl. 42–87).

July 21, 1959

2,895,248; **BOX–TYPE CARTRIDGE MAGAZINE**; Raymond R. Sawin; Hamden, Conn.; assignor to O.F. Mossberg & Sons, Inc.; New Haven, Conn.; a corporation of Connecticut; Application July 24, 1957; Serial No. 673,826; 8 Claims; (Cl. 42–50).

2,895,381; **TRIGGER RELEASE MECHANISM FOR A PLURALITY OF GUNS**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Original application February 24, 1953; Serial No. 338,627; now Patent No. 2,805,603; dated September 10, 1957; Divided and this application July 18, 1957; Serial No. 672,845; 2 Claims; (Cl. 89–27); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,895,382; **JAM–PROOF FEED MOUTH ASSEMBLY FOR AMMUNITION CONTAINERS**; Raymond A. Starry; Levittown, Pa.; Application September 29, 1955; Serial No. 537,592; 5 Claims; (Cl. 89–34). (Granted under Title 34, U.S. Code (1952), sec. 266).

2,895,383; **GAS SYSTEM FOR FIREARMS**; Frederick P. Reed; Ludlow, Mess,; assignor to the United States of America as represented by the Secretary of the Army; Application May 8, 1957; Serial No. 657,990; 2 Claims. (Cl. 89–191). (Granted under Title 35, U.S. Code (1952), sec. 266).

July 28, 1959

2,896,353; **RESILIENT RELOADING CLIP FOR REVOLVERS**; John M. Hunt; San Mateo, Calif.; Application April 16, 1956; Serial No. 578,462; 10 Claims; (Cl. 42–89).

August 11, 1959

2,898,693; **22 CALIBER CONVERSION FOR A COLT 45 CALIBER SEMI–AUTOMATIC PISTOL**; William B. Ruger; Westport, Conn.; assignor to Sturm, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Application April 17, 1956; Serial No. 578,727; 1 Claim. (Cl. 42–77).

2,898,694; **BORE REDUCING DEVICE FOR FIRE–ARMS**; Georges Senutovitch; Montreal, Quebec, Canada; Application March 8, 1957; Serial No. 644,840; 3 Claims; (Cl. 42–77).

2,898,811; **MOUNT FOR ROTATABLE MULTIPLE–BARREL–GUN**; Dean R. Heible; Hawthorne, Calif.; assignor to North American Aviation, Inc.; Application September 4, 1956; Serial No. 607,880; 11 Claims; (Cl. 89–37).

2,898,812; **ELECTRICAL GUN–SWITCH ASSEMBLY**; Edward J. Meyer; Normandy, Mo.; assignor to North American Aviation, Inc.; Application July 10, 1957; Serial No. 670,929; 3 Claims; (Cl. 89–135).

August 18, 1959

2,899,864; **HIGH VELOCITY GUN SYSTEM**; Daniel E. Bloxsom, Jr.; Tullahoma, Tenn.; Application December 26, 1956; Serial No. 630,716; 3 Claims; (Cl. 89–7). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,899,865; **CARTRIDGE FEEDING MECHANISM**; Richard H. Colby; South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application June 27, 1956; Serial No. 594,334; 1 Claim; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,899,866; **BLAST–CONTROLLING MEANS**; Herbert Clark; Dallas; Payl M. Owen, Arlington; and Marvin G. Starr, Dallas, Tex.; assignors to Chance Vought Aircraft Incorporated, Dallas, Tex,; a corporation of Delaware; Application January 20, 1956; Serial No. 560,379; 13 Claims (Cl. 89–37.5).

August 25, 1959

2,900,752; **CHOKE CONTROL DEVICE FOR SHOTGUN BARRELS**; Val A. Browning; Ogden, Utah; assignor to Browning Industries, Inc.; Ogden, Utah; a corporation of Utah; Application February 3, 1958; Serial No. 712,931; 6 Claims; (Cl. 42–79).

2,900,875; FLASH AND NOISE SUPPRESSOR FOR HIGH PRESSURE GAS EXHAUSTS; John H. Fergus; Media, Pa.; and Aaron W. Horton, Cincinnati, Ohio; assignors to the United States of America as represented by the Secretary of the Army; Application May 11, 1950; Serial No. 161,336; 4 Claims; (Cl. 89–14).

2,900,876; COMBINED RAMMER AND CAM MEANS FOR CHAMBERING CARTRIDGES IN REVOLVER–TYPE GUNS; John G. Brubaker, Park Forest; Eugene S. Wassel, La Grange; and William E. Reynolds, Riverside, Ill.; assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Application September 11, 1956; Serial No. 609,331; 1 Claim; (Cl. 89–155).

2,900,877; RECOIL–ACTION MACHINE GUN; Douglas Sloan McClenahan; West Cornwall, Conn.; Application June 8, 1956; Serial No. 590,303; 5 Claims; (Cl. 89–173).

2,900,878; TOGGLE BREECH BLOCK LOCKING MEANS FOR A GAS PISTON OPERATED GUN; Louis Nolan Nomar; Charleston, W. Va.; assignor to Nomar Arms, Inc.; Charleston, W. Va.; a corporation of West Virginia; Application October 4, 1955; Serial No. 538,340; 2 Claims; (Cl. 89–189).

September 1, 1959

2,901,853; REPEATING FIREARM WITH PIVOTED LOCKING BOLT; Jean Fontvieille, Saint-Etienne, France, assignor to Manufacture Francaise d'Armes et Cycles de Saint-Etienne, Saint-Etienne, France, a French joint-stock company; Application July 5, 1957, Serial No. 670,087; Claims priority, application France February 12, 1957; 25 Claims. (Cl. 42–21).

2,901,854; THUMB, FACE, AND EYE GUARD ATTACHMENT FOR RIFLES; Jessie T. Ivy, Seattle, Wash.; Application June 18, 1956, Serial No. 592,156; 3 Claims. (Cl. 42–71).

2,901,945; FIRING CONTROL SYSTEM; Benjamin Schalachman, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy; Application March 29, 1957, Serial No. 649,575; 2 Claims. (Cl. 89–137); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 8, 1959

2,902,788; SINGLE TRIGGER FOR PLURAL FIRING MECHANISMS; Creston F. Laager, Delanco, N. J.; Application April 9, 1958, Serial No. 727,508; 5 Claims. (Cl. 42–69); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,902,903; CLEANING DEVICE FOR A GAS OPERATED FIREARM; Val A. Browning, Ogden, Utah, assignor to Browning Industries, Inc., Ogden, Utah, a corporation of Utah; Application September 11, 1958, Serial No. 760,363; 3 Claims. (Cl. 89–191).

September 15, 1959

2,903,809; CARTRIDGE MAGAZINE OF ALUMINUM OR MAGNESIUM; Eugene M. Stoner, Los Angeles, Calif., assignor to Fairchild Engine & Airplane Corporation, Hagerstown, Md.; Application February 21, 1956, Serial No. 566,836; 6 Claims. (Cl. 42–50).

2,903,945; FIRE CONTROL SYSTEM; William K. Mann, Arkansas City, Kans.; Application September 5, 1956, Serial No. 611,806; 1 Claim. (Cl. 89–41).

September 22, 1959

2,905,056; FEEDER DEVICE FOR THE AUTOMATIC LOADING OF GUNS; Henri Nectoux, Saint-Germain-en-Laye, France, assignor to Societe des Forges et Ateliers du Creusot, Paris, France; Application June 6, 1956, Serial No. 589,760; Claims priority, application France December 8, 1955; 6 Claims. (Cl. 89–33).

2,905,057; GUN CARRIAGE; Heinrich Herlach, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a Swiss company; Application July 26, 1954, Serial No. 445,737; Claims priority, application Switzerland July 28, 1953; 2 Claims. (Cl. 89–40).

2,905,058; TRIGGER MECHANISMS FOR RECOILING AUTOMATIC GUNS OF THE OPEN BREECH TYPE; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S. A., Geneva, Switzerland, a Swiss society; Application May 16, 1955, Serial No. 508,646; Claims priority, application Luxemburg, May 21, 1954; 1 Claim. (Cl. 89–150).

September 29, 1959

2,906,175; MUZZLE SEALING APPARATUS; Henry H. Mohaupt, Fort Worth, Tex.; Application October 8, 1954, Serial No. 461,231; 2 Claims. (Cl. 89–1).

2,906,176; **QUICK DETACHABLE GUN SUPPORTING TRIPOD**; C Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application July 18, 1957, Serial No. 672,846; 3 Claims. (Cl. 89–40); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 6, 1959

2,907,250; **GUNS**; Fernando Garcia Prieto, Los Angeles, Calif.; Application November 4, 1954, Serial NO. 466,856; 1 Claim. (Cl. 89–8).

2,907,251; **CARTRIDGE GUIDING DEVICE**; Carl Gustav Ingemar Sahlberg, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish corporation; Application April 24, 1957, Serial No. 654,908; Claims priority, application Sweden April 26, 1956; 5 Claims. (Cl. 89–47).

October 13, 1959

2,908,097; **FIREARM MAGAZINE CONSTRUCTION**; Harold D. Allyn, Springfield, Mass.; Application November 19, 1957, Serial No. 697,422; 4 Claims. (Cl. 42–18).

2,908,098; **COCKING MECHANISM FOR BREECH LOADING FIREARM**; Luigi Picollo, Milan, Italy; Application December 21, 1956, Serial No. 629,875; Claims priority, application Italy June 13, 1956; 5 Claims. (Cl. 42–43).

October 20, 1959

2,908,987; **FIREARM WITH SIDE LOADING MAGAZINE**; Harold D. Allyn, Springfield, Mass.; Application June 25, 1957, Serial No. 667,924; 8 Claims. (Cl. 42–18).

2,909,100; **TRIGGER MECHANISM FOR FIREARMS**; Horace Kennerley-Tayler, Cheshunt, England, assignor to Minister of Supply in Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland; Application December 11, 1957, Serial No. 702,101; Claims priority, application Great Britain December 14, 1956; 1 Claim. (Cl. 89–140).

2,909,101; **GAS OPERATED FIREARM WITH GAS PISTON SURROUNDING A TUBULAR MAGAZINE**; Robert L. Hillberg, West Cheshire, Conn., assignor of one-half to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut, and one-half to Sears, Roebuck and Co., Chicago, Ill., a corporation of Illinois; Application March 22, 1954, Serial No. 417, 541; 6 Claims. (Cl. 89–191).

November 3, 1959

2,910,795; **MAGAZINE AND CARTRIDGE CLIP COMBINATION**; Georg Agren; Halsingborg, Sweden; Application June 20, 1957; Serial No. 666,810; Claims priority; application Sweden February 8, 1957; 7 Claims; (Cl. 42–50).

2,910,917; **DRUM MAGAZINE FOR AUTOMATIC FIRE ARMS**; Heinrich Herlach and Rudolf Stadelmann; Zurich, and Wolfgang Rossmanith, Wabern, Bern, Switzerland, assignors to Machine Tool Works Oerlikon; Administration Company, Zurich-Oerlikon, Switzerland; a company of Switzerland; Application August 13, 1956; Serial No. 603,472; Claims priority, application Switzerland August 16, 1955; 4 Claims; (Cl. 89–33).

2,910,918; **GUN RECOIL SPRING BEARING ON BARREL AND BREECH BLOCK**; John B. Jewett, Newtown, Ohio; assignor to Sportarms Manufacturing and Development Corporation, Newport, Ky.; Application May 28, 1954; Serial No. 433,158; 2 Claims; (Cl. 89–196).

November 17, 1959

2,912,779; **FIREARM WITH MEANS FOR EXTRACTION AND EJECTION OF RIMFIRE CARTRIDGES**; Robert T. Catlin, Trumbull, and Alfred W. Hamann, Easton, Conn.; and Merle H. Walker, Ilion, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Application May 7, 1956; Serial No. 583,146; 2 Claims; (Cl. 42–25).

2,912,781; **STOCK AND ACTION CLAMP**; Albert J. Lizza; Willimansett, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Application December 20, 1957; Serial No. 704,220; 2 Claims; (Cl. 42–75). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,912,901; **SINGLE POWER STROKE THRUSTER WITH SPLIT CARTRIDGE CASE LOCK**; William J. Kroeger and Sylvan D. Rolle, Philadelphia, Pa.; Application February 15, 1957; Serial No. 640,561; 4 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

November 24, 1959

2,913,961 **GUN FIRE DEAD AREA CONTROL APPARATUS**; Wentworth H. Schofield, Ridgewood, N.J.; assignor to the United States of America as represented by the Secretary of the Army; Application May 8, 1958; Serial No. 734,063; 1 Claim; (Cl. 89–41). (Granted under Title 35, U.S. Code (1952), sec. 266).

December 1, 1959

2,914,877; **TRIGGER SAFETY DEVICE FOR FIREARMS**; Thomas H. Willenbacher, East Worcester, N.Y.; Application April 7, 1958; Serial No. 726,735; 2 Claims; (Cl. 42–70).

December 8, 1959

2,915,946; **SEGMENTED MOLYBDENUM GUN LINER**; John W. Marden; East Orange, N.J.; assignor to Westinghouse Electric Corporation; East Pittsburgh, Pa.; a corporation of Pennsylvania; Application October 30, 1951; Serial No. 253,913; 6 Claims; (Cl. 89–16).

2,915,947; **CARTRIDGE PROJECTORS AND BELTING MEANS THEREFOR**; Roland Heeley, Beverly, Mass.; assignor to the United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Application February 1, 1956; Serial No. 562,685; 10 Claims; (Cl. 89–33).

2,915,948; **AIRFLOW DEFLECTOR FOR TAIL GUN TURRETS**; Wendell B. Fehring; Wichita, Kans.; assignor to Boeing Airplane Company, Wichita, Kans.; a corporation of Delaware; Application June 7, 1956; Serial No. 589,969; 4 Claims; (Cl. 89–37.5).

December 15, 1959

2,916,844 **GUARD FOR EJECTION OPENING IN BREECH SLIDE OF FIREARM**; Douglas R. Hellstrom; Wellesley Hills, Mass.; assignor to Smith and Wesson Inc.; Springfield, Mass.; a corporation of Massachusetts; Application July 22., 1957; Serial No. 673.359; 5 Claims; (Cl. 42–16).

2,916,970; **ANTI–RECOIL GUN BARRELS**; John F. Mutter, Pendleton, Oreg.; Application February 10, 1956; Serial No. 564,711; 2 Claims; (Cl. 89–14).

December 29, 1959

2,918,846; **CONNECTOR FOR CARTRIDGE BELT LINK**; David S. Porter; Watertown, Conn.; assignor to The United States of America as represnted by the Secretary of the Army; Application September 17, 1957; Serial No. 684,624; 8 Claims; (Cl. 89–35).

2,918,847; **MACHINE GUN**; Irwin R. Barr; Kingsville, Md.; assignor to Aircraft Armaments, Inc.; Baltimore, Md.; a corporation of Maryland; Application February 16, 1955; Serial No. 488,451; 13 Claims; (Cl. 89–125).

2,918,848; **REGULATING MEANS FOR A GAS PISTON OPERATED GUN**; Bernard Maillard; Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A.; Geneva, Switzerland; a society of Switzerland; Application July 9, 1956; Serial No. 596,674; Claims priority; application Luxembourg July 26, 1955; 5 Claims; (Cl. 89–193).

January 5, 1960

2,919,513; **BREECH BOLT MOVED BY RIFLE GRIP**; Gabor Palos, Edmonton, Alberta, Canada; Application April 7, 1958, Serial No. 726,684; 2 Claims. (Cl. 42–16).

2,919,628; **PNEUMATIC GUN CONTROL**; John E. Smith, Hatboro, Pa.; Application April 25, 1956, Serial No. 580,672; 2 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,919,629; **POWDER CASES FOR USE IN BREECHLESS ANTI-RECOIL ARMS**; Hugo Abramson, Eskilstuna, Sweden; Application July 13, 1951, Serial No. 236,485; Claims priority, application Sweden August 4, 1950; 2 Claims. (Cl. 89–1.7).

2,919,630; **FIREARM WITH BREECH BLOCK RETARDING MEANS**; Williard J. Hoyt, Castleton-on-Hudson, N.Y.; Application June 14, 1957, Serial No. 665,789; 10 Claims. (Cl. 89–183).

January 12, 1960

2,920,413; **ARCTIC TRIGGER**; Andrew J. Marhefka, Port Morris, N.J., and Irving L. Kintish, Bronx, N.Y., assignors to the United States of America as represented by the Secretary of the Army; Application January 27, 1959, Serial No. 789,462; 5 Claims. (Cl. 42–69); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,920,530; **AUTOMATIC GUN CHARGER**; Bernard Stevens, Skokie, and Eugene S. Wassel, La Grange, Ill., assignors to the United States of America as represented by the Secretary of the Air Force; Application October 11, 1956, Serial No. 615,440; Application October 11, 1956, Serial No. 615,440; 6 Claims. (Cl. 89–1).

2,920,531; **AUTOMATIC INDEXING DEVICE**; Homer E. Helm, Birmingham, Mich., assignor to the United States of America as represented by the Secretary of the Army; Application April 24, 1957, Serial No. 654,973; 8 Claims. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,920,533; **SELF-EJECTING BREECH**; C Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application October 7, 1957, Serial No. 688,793; 2 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,920,535; **SUPPLYING AMMUNITION TO AUTOMATIC GUNS**; Roy G. Vickers, Grantham, England, assignor to Brevets Aero-Mecaniques, S.A., Geneva, Switzerland, a corporation of Switzerland, Application April 2, 1958, Serial No. 725,940; Claims priority, application Great Britain April 16, 1957; 8 Claims. (Cl. 89–33).

2,920,536; **RECOIL AND SHOCK ABSORBING MEANS FOR A RECIPROCATING GUN**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Application October 3, 1955, Serial No. 538,227; Claims priority, application Luxembourg October 16, 1954; 2 Claims. (Cl. 89–44).

2,920,537; **CHAMBER ALIGNING DEVICE FOR SPLIT-CHAMBER AUTOMATIC SHOTGUNS**; Ernest P. Simmons, Kansas City, Kans.; Application May 12, 1958, Serial No. 734,588; 3 Claims. (Cl. 89–156).

2,920,538; **BOLT MECHANISM FOR FIREARMS**; Albert J. Lizza, Willimansett, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application January 2, 1958, Serial No. 706,880; 5 Claims. (Cl. 89–185); (Granted under Title 35, U.S. Code (1952), sec. 266).

January 19, 1960

2,921,396; **BARREL WEIGHT AND MOUNT ASSEMBLY FOR FIREARMS**; Lawrence L. Larson, Bethany, Conn., assignor to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut; Application February 6, 1909, Serial No. 791,581; 3 Claims. (Cl. 42–1).

2,921,502; **SEAR RELEASE FOR AN AUTOMATIC FIREARM**; Rudolf Amsler, Neuhausen am Rheinfall, Switzerland, assignor to Schweizerische Industrie-Gesellschaft, Neuhausen am Rheinfall, Switzerland; Application April 22, 1957, Serial No. 654,374; Claims priority, application Switzerland August 28, 1956; 3 Claims. (Cl. 89–149).

2,921,503; **AUTOMATIC FIREARM**; Val A. Browning, Ogden, Utah; Application August 31, 1953, Serial No. 377,295; 62 Claims. (Cl. 89–195).

January 26, 1960

2,922,240; **FIREARM WITH INTERENGAGEABLE BREECH BLOCK AND SLIDE BLOCK AND DOUBLE-ACTION BARS**; Harold D. Allyn, Springfield, Mass.; Application February 17, 1956, Serial No. 566,267; 6 Claims. (Cl. 42–16).

2,922,241; **TRIGGER MECHANISM WITH A BREECH BOLT SENSING ELEMENT**; Lawrence J. Brunelle, East Haven, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application August 4, 1958, Serial No. 752,729; 5 Claims. (Cl. 42–69).

2,922,242; SHOT PATTERN CONTROL DEVICE FOR SHOT GUNS; Frank A. Pachmayr, Culver City, and Lloyd L. Huskey, Alhambra, Calif.; said Huskey assignor to said Pachmyr; Application April 28, 1958, Serial No. 731,482; 6 Claims. (Cl. 42–79).

2,922,338; LARGE CALIBER SMOOTH BORE MORTARS; Georges Barbe, Paris, France; Application March 4, 1955, Serial No. 492,103; Claims priority, application France March 16, 1954; 5 Claims. (Cl. 89–1).

2,922,339; GUN COOLING VALVE; George A. Hawkins, West Lafayette, Ind., assignor to the United States of America as represented by the Secretary of the Army; Application November 30, 1945, Serial No. 632,068; 4 Claims. (Cl. 89–1).

2,922,341; PROJECTILE PROPELLING SYSTEM; John W. Treat, Jr., East Hampton, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn.; Application November 7, 1955, Serial No. 545,290; 3 Claims. (Cl. 89–7).

February 2, 1960

2,923,204; PROPELLANT CHAMBER MEANS; Henry H. Mohaupt, Fort Worth, Tex.; Application October 8, 1954, Serial No. 461,272; 7 Claims. (Cl. 89–1).

2,923,205; AUTOMATIC ARMS; Arturo Bardelli, Rome, Italy; Application October 3, 1956, Serial No. 613,747; Claims priority, application Italy October 8, 1955; 1 Claim. (Cl. 89–190).

February 9, 1960

2,924,149; RECOILLESS GUN WITH REVERSE GAS FLOW; C. Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application October 7, 1957, Serial No. 688,794; 1 Claim. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,924,150; INDIRECT CARTRIDGE FEED MECHANISMS OF THE ROTOR TYPE FOR SLIDING BREECH AUTOMATIC GUNS; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a Swiss society; Application May 16, 1955, Serial No. 508,645; Claims priority, application Luxembourg May 25, 1954; 4 Claims. (Cl. 89–33).

February 16, 1960

2,924,904; RUBBER STOCK BUTT FOR A FIREARM; Rudolf Amsler, Neuhausen am Rheinfall, Switzerland, assignor to Schweizerische Industrie-Gesellschaft, Neuhausen am Rheinfall, Switzerland; Application June 13, 1957, Serial No. 665,386; Claims priority, application Switzerland June 18, 1956; 1 Claim. (Cl. 42–74).

2,925,014; ANTI-RECOIL ARMS; Hugo Abramson, Eskilstuna, Sweden; Application December 7, 1956, Serial No. 627,073; Claims priority, application Sweden August 4, 1950; 3 Claims. (Cl. 89–1.7).

2,925,015; RIM-GRIPPING CARTRIDGE BELT LINK; Harlan C. Clark, Oxford, and Roy S. Sanford, Woodbury, Conn., assignors to the United States of America as represented by the Secretary of the Army; Application August 28, 1957, Serial No. 680,900; 1 Claim. (Cl. 89–35).

February 23, 1960

2,925,679; MAGNETIC GUN RECOIL PAD STRUCTURE; Norman A. Bivens, North Hollywood, Calif.; Application June 13, 1958, Serial No. 741,858; 7 Claims. (Cl. 42–74).

March 1, 1960

2,926,445; MAGAZINE GUN WITH MANUAL RELOADING MECHANISM; Frank T. Green and Wilfred I. Smith, Haydenville, Mass., assignors to Noble Manufacturing Co. Inc., Haydenville, Mass., a corporation of Massachusetts; Application June 28, 1957, Serial No. 668,719; 1 Claim. (Cl. 42–17).

2,926,446; FIREARM FIRING MECHANISM; Carl H. Benson, New Haven, Conn., assignor to O. F. Mossberg & Sons, Inc., New Haven, Conn., a corporation of Connecticut; Application March 31, 1958, Serial No. 725,238; 5 Claims. (Cl. 42–69).

2,926,447; SAFETY FOR FIREARM SEAR; Frank C. Scripter, Laingsburg, Mich.; Application April 28, 1958, Serial No. 731,289; 4 Claims. (Cl. 42–70).

2,926,448; **RIFLE WITH SUPPORTING ATTACHMENT FOR OFFHAND SHOOTING**; Richard Stam, East Rochester, N.Y.; Application March 20, 1959, Serial No. 800,837; 6 Claims. (Cl. 42–71).

2,926,566; **DEVICE FOR ACCELERATING THE IGNITION OF THE PROPELLANT FOR A PROJECTILE**; Walter W. Atkins, Alexandria, Va., and Paul W. Bixby, Jr., Riverdale, Md., assignors to the United States of America as represented by the Secretary of the Navy; Application November 30, 1956, Serial No. 625,555; 1 Claim. (Cl. 89–28); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,926,567; **RECEIVER MECHANISM FOR FEEDING AND POSITIONING AMMUNITION IN A GUN**; Raymond W. Warren, McLean, Va., assignor to the United States of America as represented by the Secretary of the Navy; Application September 23, 1953, Serial No. 382,014; 8 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,926,568; **FEEDING SYSTEM, CONTINUOUS CLIP TYPE**; Maxwell J. Neder, Pomona, Calif., assignor to the United States of America as represented by the Secretary of the Army; Application March 16, 1959, Serial No. 799,825; 6 Claims. (Cl. 89–126); (Granted under Title 35, U.S. Code (1952), sec. 266).

March 8, 1960

2,927,390; **SINGLE AND DOUBLE ACTION REVOLVER FIRING MECHANISM**; Karl R. Lewis, Miami, Fla.; Application January 31, 1955, Serial No. 484,999; 9 Claims. (Cl. 42–65).

March 22, 1960

2,929,163; **RETENTION MEANS FOR FIREARM EXTRACTOR**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application December 23, 1958, Serial No. 782,609; 4 Claims. (Cl. 42–25); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,929,164; **VENTILATED SIGHTING RIB FOR FIREARMS**; Val A. Browning, Ogden, Utah, assignor to Browning Industries, Inc., Ogden, Utah, a corporation of Utah; Application September 5, 1956, Serial No. 608,138; 1 Claim. (Cl. 42–76).

April 12, 1960

2,932,108; **BREECH BOLT MECHANISM FOR REPEATING RIFLES**; Alvin M. Hughel, Monroe, and John C. Buchanan, Seattle, Wash.; Application May 21, 1956, Serial No. 585,994; 2 Claims. (Cl. 42–18).

April 19, 1960

2,932,915; **CHOKE-COMPENSATOR ADAPTOR FOR METAL-PLASTIC FIREARM BARREL**; John L. Wilson, Madison, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application October 2, 1957, Serial No. 687,786; 3 Claims. (Cl. 42–79).

2,933,020; **TILT TRAY**; Edmond W. Hammer, Jr., Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of the Army; Application November 20, 1957, Serial No. 697,747; 8 Claims. (Cl. 89–45).

April 26, 1960

2,933,842; **SLEEVE-TYPE MAGAZINE CATCH AND DUST COVER FOR FIREARMS**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Application September 29, 1959, Serial No. 843,316; 5 Claims. (Cl. 42–18); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,933,843; **ADJUSTABLE HAND-STOP FOR FIREARMS**; Robert J. McFeeter, Bloomfield, N.J.; Application November 4, 1957, Serial No. 694,386; 3 Claims. (Cl. 42–85).

2,933,980; **INTEGRATED AIRCRAFT AND FIRE CONTROL AUTOPILOT**; John R. Moore, Fullerton, and David G. Soergel, Long Beach, Calif., assignors to North American Aviation, Inc.; Application August 3, 1953, Serial No. 371,756; 17 Claims. (Cl. 89–1).

2,933,982; **RAMMING DEVICE FOR RAMMING A ROUND OF AMMUNITION INTO A GUN BARREL**; Henry Wilhelm Aldria, Bofors, Sweden, assignor to Aktiebolaget Bofors, Sweden, a company of Sweden; Application June 9, 1958, Serial No. 740,910; Claims priority, application Sweden June 8, 1957; 4 Claims. (Cl. 89–47).

2,933,983; **SEMI-AUTOMATIC PISTOL**; William B. Ruger, Southport, Conn., assignor to Sturm, Ruger & Company, Inc., Southport, Conn., a corporation of Connecticut; Application March 20, 1958, Serial No. 722,669; 7 Claims. (Cl. 89–194).

May 3, 1960

2,935,000; **COMBINATION TORQUE AND RECOIL COMPENSATOR AND BARREL BUSHING FOR GUNS**; William L. Mowrey, Fort Worth, Tex., assignor of one-half to Palmer R. Bonds, Jr., Fort Worth, Tex.; Application April 14, 1954, Serial No. 423,022; 6 Claims. (Cl. 89–14).

2,935,001; **GUN FIRING SOLENOID**; Carl Henry Buecker, Fort Wayne, Ind., assignor to The Magnavox Company, Fort Wayne, Ind., a corporation; Application June 7, 1955, Serial No. 513,736; 5 Claims. (Cl. 89–135).

May 10, 1960

2,935,808; **SET TRIGGER MECHANISM**; William B. Woodring, Hamden, and Richard E. Morgan, North Haven, Conn., assignors to Olin Mathieson Chemical Corporation; Application April 1, 1958, Serial No. 725,691; 1 Claim. (Cl. 42–69).

2,935,912; **EROSION-AND-CORROSION-RESISTANT GUN BARREL ADAPTED TO HOLD A COOLANT**; James C. Hartley, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Application October 11, 1950, Serial No. 189,643; 30 Claims. (Cl. 89–14.1).

2,935,913; **GUN BARREL**; John L. Wilson, Madison, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application April 24, 1956, Serial No. 580,198; 2 Claims. (Cl. 89-16).

2,935,914; **LINKLESS FEED SYSTEM FOR GUNS**; Burns Darsie, Rockford, Ill., and Roger Herman Casler, Washington, Conn., assignors to the United States of America as represented by the Secretary of the Army; Application August 5, 1957, Serial No. 676,454; 19 Claims. (Cl. 89–33).

2,935,915; **GAS-OPERATED AUTOMATIC RIFLE HAVING A PLURALITY OF BARRELS**; Stefan Kenneth Janson, New Haven, Conn., assignor to Olin Mathieson Chemical Corporation, New Haven, Conn., a corporation of Virginia; Application June 27, 1956, Serial No. 594,319; 2 Claims. (Cl. 89–193).

May 17, 1960

2,936,677; **SUPPLYING AMMUNITION TO AUTOMATIC GUNS**; Roy G. Vickers, Grantham, England, assignor to Brevets Aero-Mecaniques, S.A., Geneva, Switzerland, a corporation of Switzerland; Application April 2, 1958, Serial No. 725,939; Claims priority, application Great Britain April 16, 1957; 5 Claims. (Cl. 89–33).

May 24, 1960

2,937,465; **AUTOMATIC CHOKE ATTACHMENT FOR SHOTGUNS**; Louis M. Denaux, Ser., 360 Spring St., Charleston, S.C.; Filed Dec. 29, 1958, Serial No. 783,360; 3 Claims. (Cl. 42–79).

May 31, 1960

2,938,432; **REMOTE CONTROL DEVICE**; Andrew J. Grandy, North Hills, Pa., and William E. Perkins, Runnemede, N.J., assignors to the United States of America as represented by the Secretary of the Army; Filed Jan. 6, 1959, Serial No. 785,301; 2 Claims. (Cl. 89–27); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,938,433; **BIPED MORTAR MOUNT**; Joseph Raymond Jasse, Paris, France, assignor to Ste: Hotchkiss-Brandt, Paris, France, a corporation of France; Filed Dec. 26, 1957, Serial No. 705,287; Claims priority, application France Dec. 28, 1956; 1 Claim. (Cl. 89–37).

June 14, 1960

2,940,201; **BOLT ACTUATED COVER FOR EJECTION PORTS IN FIREARM RECEIVERS**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 4, 1959, Serial No. 797,316; 3 Claims. (Cl. 42–16); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,940,202; **TARGET PISTOL**; Murry D. Harper, 218 22nd St., Dunbar, W. Va.; Filed Oct. 4, 1957, Serial No. 688,277; 8 Claims. (Cl. 42–69).

2,940,364; **BASE PLATE FOR MORTARS AND THE LIKE**; Joseph Raymond Jasse, Paris, France, assignor to Hotchkiss-Brandt, Paris, France, a French body corporate; Filed July 17, 1957, Serial No. 672,476; Claims priority, application France July 18, 1956; 7 Claims. (Cl. 89–37).

June 21, 1960

2,941,326; **RESILIENT BARREL SUPPORTING DEVICE FOR FIREARMS**; James K. Hamil, Westport, Conn., and Charles C. Webb, Wilmington, Del., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Filed May 7, 1958, Serial No. 733,535; 6 Claims. (Cl. 42–75).

2,941,448; **PERCUSSION MECHANISM**; Edgar William Brandt, Geneva, Switzerland, assignor to Anstalt fur die Entwicklung von Erfindungen und gewerblichen Anwendungen Energa, Vaduz, Liechtenstein, a corporation; Filed Dec. 16, 1957, Serial No. 703,134; Claims priority, application Switzerland Jan. 18, 1957; 2 Claims. (Cl. 89–1.7).

2,941,449; **DECELERATING DEVICE FOR FIREARMS WITH TELESCOPIC BOLTS**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 4, 1959, Serial No. 797,317; 1 Claim. (Cl. 89–185); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,941,450; **GAS OPERATING MECHANISM FOR AN AUTO-LOADING FIREARM**; Lexie Ray Crittendon, Wilmington, Del., Ellis William Hailston, Ilion, N.Y., Philip Richard Haskell, Flossmoor, Ill., and Robert Peter Kelly and Wayne Edwin Leek, Ilion, N.Y., assignors to Remington Arms Company, Inc., a corporation of Delaware; Filed May 2, 1956, Serial No. 582,153; 3 Claims. (Cl. 89–191).

June 28, 1960

2,942,369; **FIRING PIN AND BREECH BOLT SAFETY**; Alan Emanuel, 519 Hickory St., Anaconda, Mont.; Filed Aug. 28, 1958, Serial No. 757,762; 5 Claims. (Cl. 42–70).

2,942,523; **CHARGING DEVICES FOR A FIREARM**; Burns Darsie Watertown, Conn., assignor to the United States of America as represented by the Secretary of the Army; Filed June 18, 1953, Serial No. 334,764; 16 Claims. (Cl. 89–1).

2,942,524; **MACHINE GUN COOLING SYSTEM**; George A. Hawkins, Lafayette, Ind., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed Dec. 19, 1947, Serial No. 792,722; 19 Claims. (Cl. 89–14).

2,942,525; **OBTURATOR**; Joseph L. Gillman, Jr., United States Navy; Filed May 31, 1945, Serial No. 596,931; 1 Claim. (Cl. 89–26).

July 5, 1960

2,943,411; **SAFETY LOCK FOR REVOLVERS**; John Salva, 118 Cathay Road, Clifton, N.J.; Filed July 7, 1959, Serial No. 825,507; 2 Claims. (Cl. 42–66).

2,943,412; **TRIGGER OPERATING MEANS FOR A PISTOL**; John M. McNally, Newington, Conn., assignor, by mesne assignments, to Colt's Patent Fire Arms Manufacturing Company, Incorporated, Hartford, Conn., a corporation of Arizona; Filed Sept. 18, 1953, Serial No. 381,042; 8 Claims. (Cl. 42–69).

July 12, 1960

2,944,357; **CARTRIDGE MAGAZINE FOLLOWER FOR AUTOMATIC PISTOLS**; Donald R. Smith, Sierra Madre, and Donald B. H. Coates, Pasadena, Calif., assignors to Western Follower Corporation, Gardena, Calif., a corporation of California; Filed May 15, 1958, Serial No. 735,439; 2 Claims. (Cl. 42–50).

2,944,359; **REVOLVER LOADING DEVICE**; John A. Hanley, Noroton, Conn.; Margaretta C. Hanley executrix of said John A. Hanley, deceased, assignor of one-half to Albert J. Silmak, Stamford, Conn.; Filed Nov. 15, 1957, Serial No. 696,787; 2 Claims. (Cl. 42–89).

July 19, 1960

2,945,316; **SAFETY LOCK FOR FIREARMS**; Lester F. Mulno, Worcester, Mass., assignor to Harrington & Richardson, Inc., Worcester, Mass., a corporation of Massachusetts; Filed May 9, 1958, Serial No. 734,186; 16 Claims. (Cl. 42–66).

2,945,422; **FIREARM**; Harold D. Allyn, 10 Sumner Ave., Springfield, Mass.; Filed June 19, 1956, Serial No. 592,430; 4 Claims. (Cl. 89–154).

2,945,423; **FIREARM**; Harold D. Allyn, 10 Sumner Ave., Springfield, Mass.; Filed June 25, 1957, Serial No. 667,883; 4 Claims. (Cl. 89–199).

July 26, 1960

2,946,262; **COMBINED GUN EQUILIBRATOR AND ELEVATION CYLINDER**; Lawrence Bruehl, Vestal, N.Y., assignor to International Business Machines Corporation, New York, N.Y., a corporation of New York; Filed Sept. 12, 1952, Serial No. 309,344; 13 Claims. (Cl. 89–37).

2,946,263; **GUN EQUILIBRATOR**; Lawrence Bruehl, Vestal, N.Y., assignor to International Business Machines Corporation, New York, N.Y., a corporation of New York; Filed Sept. 12, 1952, Serial No. 309,345; 7 Claims. (Cl. 89–37).

2,946,264; **LOADING MECHANISM**; Alexander D. F. Moncrieff, Bloomfield Hills, Mich., assignor to Michigan Tool Company, Detroit, Mich., a corporation of Delaware; Field Nov. 21, 1955, Serial No. 547,920; 15 Claims. (Cl. 90–1.6).

August 2, 1960

2,947,220; **SINGLE TRIGGER SEQUENTIAL FIRING MECHANISM**; Creston F. Langer, Beverly, N.J., assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 23, 1958, Serial No. 710,825; 1 Claim. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,947,221; **COMPRESSION IGNITION GUN**; Donald N. Griffin, Niagra Falls, N.Y., and John W. Orr, Duarte, Calif., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Dec. 10, 1956, Serial No. 627,724; 2 Claims. (Cl. 89–7).

2,947,222; **AMMUNITION LINK**; Andrew G. Bilek and Elvyn G. Roser, Oklaoosa County, Fla., assignors to the United States of America as represented by the Secretary of the Air Force; Filed Aug. 5, 1957, Serial No. 676,448; 3 Claims. (Cl. 89–35); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 9, 1960

2,948,075; **FIREARM EJECTOR MOUNTED ON A MOVABLE CHAMBER EXTENSION**; Arthur S. Yeomans, Jr., North Haven, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed July 19, 1957, Serial No. 672,906; 2 Claims. (Cl. 42–25).

2,948,192; **REMOTE SAFETY FIRING MECHANISM**; Paul I. Evans, Livermore, and Maurice R. Ransom, Torrance, Calif., assignors to the United States of America as represented by the Secretary of the Army; Filed Mar. 4, 1959, Serial No. 797,319; 1 Claim. (Cl. 89–28).

2,948,193; **ALTERNATING PULSE SERVO SYSTEM**; Ward Leathers, Brooklyn, Frank J. Furman, Endicott, and Hugo A. Panissidi, Binghamton, N.Y., assignors to International Business Machines Corporation, New York, N.Y., a corporation of New York; Filed Sept. 8, 1953, Serial No. 378,696; 5 Claims. (Cl. 89–41).

2,948,194; **BURST LIMITING DEVICE FOR AUTOMATIC WEAPONS**; Charles Louis Godar, Paris, France, assignor to Etude et Realisation d'Outillage de Precision C. L. Godar et Cle, Courbevole, France, a corporation of France; Filed Apr. 16, 1957, Serial No. 653,224; Claims priority, application France Apr. 19, 1956, 9 Claims. (Cl. 89–129).

2,948,195; **BREECH MECHANISM FOR AUTOMATIC FIREARMS**; Friedrich Linder, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Filed Feb. 3, 1958, Serial No. 712,813; Claims priority, application Switzerland Feb. 7, 1957; 1 Claim. (Cl. 89–183).

August 16, 1960

2,948,978; **TRIGGER GUARD WITH TRIGGER PROTECTOR**; Robert E. Salverda, 2118 N. Dale St., St. Paul, 13, Minn.; Filed Sept. 4, 1958; Serial No. 759,020; 3 Claims; (Cl. 42)1).

2,949,061; **RECOILLESS RIFLE WITH EXPANDING NOZZLE**; Albert Benditt, Philadelphia, Pa., and C. Walton Musser, Beverly, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed Aug. 3, 1959, Serial No. 831,446; 1 Claim. (Cl. 89–1.7).

August 23, 1960

2,949,824; **ORDNANCE CALCULATING APPARATUS**; Clifford F. Abt, Long Island City, Richard Y. Miner, Port Washington, and Arnold Spitalny, New York, N.Y., assignors to American Bosch Arma Corporation; Filed June 1, 1953, Serial No. 358,854; 5 Claims. (Cl. 89–41).

2,949,825; **DUAL WEAPON SYSTEM ALIGNMENT MECHANISM**; C Walton Musser, Beverly, Mass., and Francis W. Dietsch, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Filed May 7, 1958, Serial No. 733,773; 3 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 30, 1960

2,950,652; **CHAMBERING MECHANISM FOR AN AUTOMATIC REVOLVER TYPE GUN**; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Dec. 20, 1957, Serial No. 704,219; 7 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,950,653; **BOLT ASSEMBLY FOR A FIREARM**; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 4, 1958, Serial No. 719,172; 3 Claims. (Cl. 89–185); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 6, 1960

2,951,422; **ARTICLE HANDLING SYSTEM FOR CARTRIDGE FEEDING**; Vincent S. Bobkowski, Los Angeles, Calif., assignor to Armament Components, Inc., Santa Ana, Calif., a corporation of California; Filed May 11, 1956, Serial No. 584,289; 21 Claims. (Cl. 89–33).

2,951,423; **MAGAZINE HOLDER FOR THE FEEDING OF FIRE ARMS, MACHINE GUNS, CANNONS AND THE LIKE**; Sestilio Florini, Italy, assignor to Breda Mercanica Bresciana S.P.A., Brescia, Italy, an Italian company; Filed May 16, 1958, Serial No. 735,859; Claims priority, application Italy May 16, 1957; 2 Claims. (Cl. 89–34).

2,951,424; **GAS OPERATED BOLT AND CARRIER SYSTEM**; Eugene M. Stoner, Los Angeles, Calif., assignor to Fairchild Engine and Airplane Corporation, Hagerstown, Md., a corporation of Maryland; Filed Aug. 14, 1956, Serial No. 603,913; 6 Claims. (Cl. 89–191).

September 13, 1960

2,952,088; **AUTOMATIC RELOADING MECHANISM FOR RIFLES WITH SLIDING BOLT ACTION**; Jessie T. Ivy, 523 Henderson St., Seattle, Wash.; Filed Aug. 12, 1958, Serial No. 754,636; 3 Claims. (Cl. 42–16).

2,952,089; **CHAMBER STRUCTURE FOR GUNS**; Karl W. Maier, Cheshire, and John L. Wilson, Madison, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Jan. 16, 1957, Serial No. 634,443; 2 Claims. (Cl. 42–76).

September 20, 1960

2,952,933; **SHELL RETAINER MOUNTED ON EXTRACTOR**; Burce W. Stevens, Walnut Creek, Calif., assignor of one-half to Llewellyn W. Evans, Orinda, Calif.; Filed June 5, 1958, Serial No. 740,108; 3 Claims. (Cl. 42–1).

2,952,934; **FIREARM WITH REARWARD SWINGING BREECH BLOCK**; Lazare Yovanovitch, 114 Guilbault Ave., Longueuil, Quebec, Canada; Filed Feb. 14, 1957, Serial No. 640,127; 1 Claim. (Cl. 42–28).

2,953,066; **FIREARM BREECH MECHANISM WITH A LATERALLY OPERATED BREECH BLOCK**; Richard H. Colby, South Hadley, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Cot. 6, 1959, Serial No. 844,832; 3 Claims. (Cl. 89–186); (Granted under Title 35, U.S. Code (1952), sec. 266).

September 27, 1960

2,953,972; **MUZZLE EQUALIZER AND BLAST MINIMIZER FOR GUN**; Hans C. Sorensen, 3395, SW. 108th Ave., Beaverton, Oreg.; Filed Sept. 2, 1958, Serial No. 758,218; 5 Claims. (Cl. 89–14).

October 4, 1960

2,954,724; **BREECH CONSTRUCTION FOR RECOILLESS RIFLE**; C Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Apr. 10, 1958, Serial No. 727,747; 3 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 11, 1960

2,955,373; **REVOLVER CYLINDER PIN AND CROSS PIN**; William B. Ruger, Southport, Conn., assignor to Sturm, Ruger and Company, Inc., Southport, Conn., a corporation of Connecticut; Filed Apr. 10, 1959, Serial No. 805,573; 1 Claim. (Cl. 42–59).

October 18, 1960

2,956,363; **SIDE CAM MAGAZINE CATCH FOR FIREARMS**; Alfred L. Montana, East Longmeadow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed June 23, 1959, Serial No. 822,399; 3 Claims. (Cl. 42–50); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,956,478; **RUBBER SHEAR MOUNT**; Joseph T. Ream, Jr., Phoenix, Ariz., and Robert Fisher, Chicago, Ill., assignors to the United States of America as represented by the Secretary of the Army; Filed Aug. 21, 1957, Serial No. 679,801; 3 Claims. (Cl. 89–1.7).

2,956,479; **CASCADED GUN BARREL**; C Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Feb. 28, 1958, Serial No. 719,386; 2 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,956,480; **AUTOMATIC SHELL EJECTOR**; Robert L. Zouck, Pikesville, Md., assignor to Aircraft Armaments, Inc., Cockeysville, Md., a corporation of Maryland; Filed May 27, 1955, Serial No. 511,532; 13 Claims. (Cl. 89–33).

2,956,481; **DUAL RATE MACHINE GUN WITH GAS CHAMBER ENCIRCLING THE BARREL**; Irwin R. Barr, Kingsville, and Patrick E. Sweeney, Baltimore, Md., assignors to Aircraft Armaments, Inc., Baltimore, Md., a corporation of Maryland, Filed Nov. 2, 1954, Serial No. 466,312; 12 Claims. (Cl. 89–129).

October 25, 1960

2,957,391; **FIRING MECHANISM FOR FIREARMS AND THE LIKE**; Charles L. Lovercheck, 632 W. 7th St., Erie, Pa.; Filed Apr. 18, 1955, Serial No. 501,944; 6 Claims. (Cl. 89–28).

November 1, 1960

2,958,151; **TRIGGER ACTUATED CYLINDER STOP FOR REVOLVERS**; Harry H. Sefried II, New Haven, Conn., assignor, by direct and mesne assignments, to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut; Filed Feb. 10, 1956, Serial No. 564,729; 1 Claim. (Cl. 42–67).

November 8, 1960

2,958,974; **TAKEDOWN DEVICE FOR FIREARMS**; Harry H. Sefried II, New Haven, Conn., assignor to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut; Filed Jan. 19, 1959, Serial No. 787,490; 2 Claims. (Cl. 42–75).

2,959,106; **PLURAL-BARREL GUN WITH DRUM AND CHAMBERING MECHANISM**; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Apr. 7, 1958, Serial No. 727,008; 5 Claims. (Cl. 89–126); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,959,107; **AUTOMATIC PISTOL FIRING MECHANISM**; Foster E. Sturtevant, West Hartford, Conn., assignor, by mense assignments, to Colt's Patent Fire Arma Manufacturing Company, Incorporated, Hartford, Conn., a corporation of Arizona; Filed Mar. 18, 1959, Serial No. 722,299; 5 Claims. (Cl. 89–145).

November 15, 1960

2,960,010; **DEVICE FOR BALANCING THE ELEVATING MASS OF A RECOILING GUN**; Henry Wilhelm Aldrin, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a company of Sweden; Filed May 26, 1958, Serial No. 737,905; Claims priority, application Sweden May 31, 1957; 6 Claims. (Cl. 89–37).

2,960,011; **AUTOMATIC FIREARM HAVING INERTIA RELEASED BREECH MECHANISM**; Rene Jean Georges Bretton, 26 rue Alexandre Pourcel, Saint-Etienne, France; Filed Apr. 18, 1957, Serial No. 653,648; Claims priority, application France May 7, 1956, 3 Claims. (Cl. 89–182).

November 22, 1960

2,960,788; **TRIGGER ANTI-BACKLASH DEVICE FOR FIREARMS**; Gary Wilheim, New Haven, Conn., assignor to The High Standard Manufacturing Corporation, Hamden, Conn., a corporation of Connecticut; Filed Feb. 6, 1959, Serial No. 791,598; 4 Claims. (Cl. 42–69).

2,960,917; **LOCK MEANS FOR TELESCOPIC FIREARM BOLTS**; Albert J. Lizza, Williamansett, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 22, 1959, Serial No. 788,473; 2 Claims. (Cl. 89–190); (Granted under Title 35, U.S. Code (1952), sec. 266).

November 29, 1960

2,961,791; **LEVER OPERATED RIFLE**; William B. Morris, Rte. 1, Box 215–B, Smithfield, Tex.; Filed Nov. 9, 1956, Serial No. 621,245; 1 Claim. (Cl. 42–16).

2,961,792; **SELF-CONTAINED ACTION UNIT FOR FIREARMS OF THE BREAKDOWN TYPE**; Harry H. Sefried II, 5 Sheldon Terrace, New Haven, Conn.; Filed Feb. 24, 1960, Serial No. 10,750; 20 Claims. (Cl. 42–41).

December 6, 1960

2,962,935; **RECOIL AND BUFFER SPRING ASSEMBLY FOR AUTOMATIC FIRE ARMS**; Erwin Hepperle, Eichelacker of Dietlikon-Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a Swiss company; Filed Dec. 18, 1957, Serial No. 703,537; Claims priority, application Switzerland Dec. 21, 1956, 1 Claim. (Cl. 89–44).

2,962,936; **AUTOMATIC FIREARM**; Hans Lippert, Kilchberg, Zurich, and Ernst Muhlemann, Zurich, Switzerland, assignors to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Filed May 26, 1958, Serial No. 737,911; Claims priority, application Switzerland May 24, 1957, 1 Claim. (Cl. 89–190).

December 13, 1960

2,963,810; **LOADING MEANS FOR BOLT-ACTION RIFLES**; Thomas R. Robinson, Jr., New Haven, Conn., assignor to The Marlin Firearms Company, New Haven, Conn., a corporation of Connecticut; Filed Oct. 7, 1958, Serial No. 765,805; 11 Claims. (Cl. 42–16).

2,963,943; **GAS PORTING DEVICE FOR A SHOTGUN**; Richard M. Cutts, The Pisima, Va.; Original application July 8, 1948, Serial No. 37,605. Divided and this application July 15, 1953, Serial No. 368,098; 4 Claims. (Cl. 89–14).

December 20, 1960

2,965,000; **LIQUID PROPELLANT, REGENERATIVE FEED AND RECOILLESS GUN**; Leslie A. Skinner, 5024 Nebraska Ave. NW., Washington, D.C.; Filed Nov. 7, 1951, Serial No. 255,294; 8 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,965,002; **GUN TRAINING CONTROL MECHANISM**; C Walton Musser, Beverly, Mass., and Albert Benditt, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Filed July 25, 1968, Serial No. 751,098; 5 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,965,004; **TRIPLE-SPROCKET TWIN-BARREL GUN**; Mitchell J. Shoelson, Hometown, and Eugene S. Wassel, La Grange, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed May 27, 1957, Serial No. 661,982; 1 Claim. (Cl. 89–126).

2,965,005; **FIRING PIN RELEASE FOR SEMI-AUTOMATIC FIREARMS**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 4, 1959, Serial No. 797,314; 2 Claims. (Cl. 89–139); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,965,006; **TWIN-BARREL GUN WITH A DRUM AND A MULTISTATION RAMMER**; John F. O'Brien, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed Sept. 26, 1955, Serial No. 536,791; 5 Claims. (Cl. 89–155); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,965,993; **SELECTIVE TRIGGER PULL MECHANISM**; Ernnett B. Perrine, 620 S. 8th St., Minneapolis, Minn.; Filed Jan. 27, 1958, Serial No. 711,349; 4 Claims. (Cl. 42–69).

December 27, 1960

2,965,994; **GUN FOREARM**; George C. Sullivan, 3085 Lake Hollywood Drive, Hollywood 28, Calif.; Filed May 20, 1957; Serial No. 660,103; 9 Claims. (Cl. 42–71).

January 3, 1961

2,966,829; **RECOIL MECHANISM**;Joseph Tannenbaum; Detroit, Mich.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 2, 1957; Ser. No. 656,732; 7 Claims; (Cl. 89–43); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,966,830; **COCKING DEVICE FOR THE BREECH MECHANISM OF AUTOMATIC FIREARMS**; Erwin Hepperle, Dietlikon; Zurich, Switzerland; assignor to Machine Tool Works Oerlikin, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Filed Dec. 18, 1958; Ser. No. 781,284; Claims priority, application Switzerland Jan. 9, 1958; 1 Claim. (Cl. 89–155).

January 10, 1961

2,967,367; **FIRING MECHANISM FOR BOLT ACTION REPEATING RIFLE**; Jessie T. Ivy; 523 Henderson St., Seattle, Wash.; Filed Nov. 15, 1957; Ser. No. 696,738; 5 Claims; (Cl. 42–69).

2,967,368; **MOUNTING OF GUN BARREL IN ITS STOCK**; Selden T. Williams; Bellerose, N.Y.; (Central Road, Middlebury, Conn.); Filed July 31, 1958; Ser. No. 752,260; 5 Claims; (Cl. 42–75).

2,967,369; **RIFLE BARREL WITH TWO SETS OF GROOVES OF DIFFERENT DEPTH AND TWIST**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 13, 1960; Ser. No. 2,313; 2 Claims; (Cl. 42–78); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,967,460; **CARTRIDGE CASE EXTERIOR AS INNER SURFACE OF ARCUATE GUN NOZZLES**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 29, 1958; Ser. No. 751,807; 1 Claim. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

January 17, 1961

2,968,111; **ADJUSTABLE GUN CHOKE**; Herbert Welles Steane, West Hartford, Conn.; assignor to The Poly Choke Company, Incorporated; Wast Hartford, Conn.; a corporation of Connecticut; Filed June 13, 1958; Ser. No. 741,769; 3 Claims; (Cl. 42–79).

2,968,223; **GUN TRAINING AND TRIGGER MECHANISM**; John Welbel, Jr.; Dayton, Ohio; assignor, by direct and mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed Dec. 1, 1959; Ser. No. 856,630; 5 Claims; (Cl. 89–41).

January 24, 1961

2,968,997; **CROSS CONNECTED SERVO MECHANISM FOR A TURRET GUN DIRECTING SYSTEM**; George C. Newton, Jr.; Cambridge, Mass.; and Walter T. White; New Hyde Park; and Edmund B. Hammong, Jr.; Albertson, N.Y.; assignors to Sperry Rand Corporation; a corporation of Delaware; Filed May 9, 1947; Ser. No. 747,008; 26 Claims; (Cl. 89–41).

February 7, 1961

2,970,398; **MECHANISM TO ENABLE FIRING OF SHOTGUN WITH ONE ARM**; Alfred H. Crouch, 21236 Cabrillo Highway; Malibu, Calif.; assignor of one-half to Rudolph A. Donatelli, Santa Monica, Calif.; Filed July 15, 1959; Ser. No. 827,383; 4 Claims. (Cl. 42–69).

2,970,399; **UNDERWATER WEAPON**; Willy O. Frohlich and Harry W. Frohlich, both of 957 Sanger St.; Philadelphia 24, Pa.; Filed Feb. 26, 1959; Ser. No. 795,673.

2,970,519; **RECOILLESS RIFLE**; C. Walton Musser; Beverly; and Kenneth R. Wadleigh, Belmont, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed Nov. 26, 1958; Ser. No. 776,653; 4 Claims; (Cl. 89–1.7).

2,970,520; **RECOILLESS RIFLE BREECH**; Andrew J. Grandy; North Hills, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 10, 1959; Ser. No. 826,377; 4 Claims; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952) sec. 266).

2,970,521; **COMBINED FIREARM AND CARTRIDGE STRUCTURE PROVIDING FOR DISCHARGE OF THE CARTRIDGES WHILE LINKED**; Charles R. Bell, Canoga Park, Calif.; and Eugene S. Wassel, La Grange, Ill.; assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed Aug. 26, 1957; Ser. No. 680,371; 2 Claims; (Cl. 89–33).

2,970,522; **DISINTEGRATING LINK ASSEMBLY FOR CARTRIDGE BELT**; Samuel S. Brady; Baltimore County, Md.; assignor to Aircraft Armaments, Inc.; Cockeysville, Md.; a corporation of Maryland; Filed Apr. 16, 1959; Ser. No. 806,898; 4 Claims; (Cl. 89–35).

February 14, 1961

2,971,438; **OFF-MOUNT MAGAZINE AMMUNITION TRANSFER MECHANISM**; Paul L. Fox, Upper Providence Township, Pa.; assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed May 11, 1951; Ser. No. 225,735; 24 Claims; (Cl. 89–45).

2,971,439; AMMUNITION CRADLE FOR CONTINUOUS HOIST;Paul E. Ebersole, Jr.; 4923 N. 34th Road, Arlington, Va.; and Raymond W. Warren, Rte. 2, Box 555; McLean, Va.; Filed July 1, 1952; Ser. No. 296,778; 7 Claims. (Cl. 89–46); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,971,440; ROTATING MULTIPLE BARREL AIRCRAFT GUN; John F. O'Brien; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 23, 1956; Ser. No. 560,910; 3 Claims; (Cl. 89–126). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,971,441; FIRE RATE CONTROL MEANS FOR A TELESCOPIC-TYPE TWO-PIECE FIREARM BOLT; Frederick P. Reed; Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 22, 1959; Ser. No. 788,474; 10 Claims; (Cl. 89–130); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 21, 1961

2,972,286; RAPID FIRE GUN WITH TWO BARRELS AND A PLURALITY OF FIRING CHAMBERS; Frank R. Marguardt; 712 15th St.; Alexandria, Va.; Filed Apr. 18, 1950; Ser. No. 156,641; 24 Claims; (Cl. 89–126); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 28, 1961

2,972,829; AUTOMATICALLY ADJUSTABLE CHOKE FOR SHOTGUNS; Arne Y. Grahn; Hartford, Conn.; assignor to The Poly Choke Company, Incorporated; East Hartford, Conn.; a corporation of Connecticut; Filed Mar. 27, 1958; Ser. No. 724,451; 8 Claims. (Cl. 42–79).

2,972,934; CONTINUOUS HOIST FOR AMMUNITION; Haviland H. Platt; New York, N.Y., and Leon Mayon, Philadelphia, Pa.; assignors, by direct and mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed May 11, 1951; Ser. No. 225,742; 7 Claims. (Cl. 89–46).

March 7, 1961

2,973,692; SINGLE-SHUTTLE TWIN-BARREL GUN; Samuel Altschuler, Skokie, Ill.; assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army, Filed Feb. 8, 1957; Ser, No. 639,142; 4 Claims; (Cl. 89–33).

2,973,693; LOADING, FIRING AND UNLOADING MECHANISM FOR A FIREARM WITH A LATERALLY ACTUATED BREECH CLOSURE; Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Oct. 7, 1959; Ser. No. 845,043; 7 Claims; (Cl. 89–169); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,973,694; BUFFER FOR AUTOMATIC FIREARMS; Freidrich Herlach, Friedrich Linder, and Wilhelm Spalding; Zurich, Switzerland; assignors to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland, a company of Switzerland; Filed Feb. 3, 1958; Ser. No. 712,814; Claims priority, application Switzerland Feb. 8, 1957; 2 Claims; (Cl. 89–198).

March 14, 1961

2,974,569; AMMUNITION FEED MECHANISM; Garrett P.S. Cross; Beverly, Mass.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Sept. 2, 1947; Ser. No. 771,677; 1 Claim; (Cl. 89–33).

2,975,540; RECEIVER ASSEMBLY; Oliver N. Lewis, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed Oct. 2, 1957; Ser. No. 764,798; 4 Claims; (Cl. 42–75).

March 21, 1961

2,975,677; GUN BARREL LINER; John R.C. Kelly, Jr.; Upper Montclair, N.J.; assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed June 26, 1952; Ser. No. 195,635; 4 Claims; (Cl. 89–16).

2,975,678; GUN-LOADING MECHANISMS; Sidney J. Finn, Beverly, Mass.; assignor to United Shoe Machinery Corporation, Flemington, N.J.; a corporation of New Jersey; Filed Mar. 20, 1946; Ser. No. 655,704; 6 Claims; (Cl. 89–45).

2,975,679; POWER SYSTEM FOR FIREARMS; David C. Fletcher, Springfield, Mass.; assignor to the Unites States of America as represented by the Secretary of the Army; Filed Nov. 27, 1956; Ser. No. 624,708; 3 Claims; (Cl. 89–192); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,975,680; SEMIAUTOMATIC PISTOL WITH BREECH BLOCK FORWARD OF MAGAZINE CHAMBER; George A. Wilson, 15 War Admiral Land, R.D. 26, Media, Pa.; Filed Apr. 22, 1958; Ser. No. 730,231; 3 Claims; (Cl. 89–196).

March 28, 1961

2,976,637; SEAR SAFETY ACTUATED BY ROTATION OF BOLT; Thomas R. Robinson, Jr.; New Haven, Conn.; assignor to the Marlin Firearms Company, New Haven, Conn.; a corporation of Connecticut; Filed Oct. 27, 1958; Ser. No. 769,894; 6 Claims; (Cl. 42–70).

2,975,638; SUBCALIBER CONVERSION ASSEMBLY FOR REVOLVERS; John G. Owens, 540 N. Louisa; Shawnee, Okla.; Filed June 13, 1958; Ser. No. 741,801; 11 Claims; (Cl. 42–77).

2,976,769; ARMOURED CAR WITH A ROTATABLY ARRANGED GUN TURRET; Franz Horn; Dusseldorf, Germany; assignor to Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed June 3, 1958; Ser. No. 739,509; Claims priority; application Germany June 8, 1957; 4 Claims; (Cl. 89–36).

2,976,770; OPERATING MECHANISM FOR A PLURAL BARREL RIFLE WITH A FEEDING ROTOR; David C. Fletcher; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 9, 1956; Ser. No. 621,487; 12 Claims; (Cl. 89–126); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,976,771; BURST CONTROL FOR AUTOMATIC RIFLES; Chandley W. Lambert, 6325 Mackenzie Road; North Olmsted, Ohio; Filed Mar. 27, 1959; Ser. No. 802,370; 3 Claims; (Cl. 89–129).

April 4, 1961

2,977,702; CHOKE WITH CONTACTING FINGER AND SLEEVE SURFACES OF CONCENTRIC ARCS; Ewald Schacht; Waseca, Minn.; Filed June 8, 1954; Ser. No. 435,112; 3 Claims; (Cl. 42–79).

2,977,703; FOREARM GUN; Howard C. Sarvis, Boulder Creek Station, New Meadows, Idaho; Filed Oct. 10, 1955; Ser. No. 539,470; 18 Claims; (Cl. 42–94).

2,977,852; TRIGGER MECHANISM; Milton J. Reuwer, Baltimore, and Bernhard Rogge, Baldwin, Md.; assignors to the United States of America as represented by the Secretary of the Army; Filed Oct. 6, 1959; Ser. No. 844,831; 3 Claims; (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,977,853; WEAPON DELIVERY METHOD AND MEANS; George R. Gehrkens and Frank G. Compton, Columbus, Ohio; assignors to North American Aviation, Inc.; Filed Dec. 1, 1955; Ser. No. 550,332; 3 Claims; (Cl. 89–1.5).

2,977,854; SINGLE-SPROCKET TWIN-BARREL GUN; Eugene S. Wassel, La Grange; and Kenneth G. Johnson, Aurora, Ill.; assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed May 29, 1957; Ser. No. 662,551; 2 Claims; (Cl 89–13).

2,977,856; FEEDING MECHANISM FOR A SALVO GUN; David C. Fletcher; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 9, 1956; Ser. No. 621,488; 2 Claims; (Cl. 89–33); (Granted under Title 35; U.S. Code (1952), sec. 266).

2,977,858; AIMING DEVICE FOR MORTARS; Joseph Raymond Jasse, Paris, France, assignor to Hotchkiss-Brandt, Paris, France, a body corporate of France; Filed July 16, 1958; Ser. No. 749,011; Claims priority, application France July 18, 1957; 7 Claims. (Cl. 89–41).

April 11, 1961

2,978,825; TOGGLE FIRING MECHANISM FOR FIREARMS; George H. Tichenor IV, 841 S. Oakland Ave.; Pasadena, Calif.; Filed Apr. 8, 1958; Ser. No. 727,164; 12 Claims; (Cl. 42–69).

2,978,826; TRIGGER SAFETY LATCH FOR FIREARMS; Jessie T. Ivy, 523 Henderson St.; Seattle, Wash.; Filed Oct. 28, 1958; Ser. No. 770,196; 2 Claims; (Cl. 42–70).

2,978,827; MEANS FOR ELECTRICALLY FIRING FIRE-ARMS; Charles Rouby; St. Etienne, France; assignor to Societe Moderne de Fabrications Mecaniques, St. Etienne, France, a French limited-liability company; Filed June 15, 1956; Ser. No. 591,736; Claims priority, application France Apr. 20, 1956; 11 Claims; (Cl. 42–84).

2,978,960; FUSE-SETTING MECHANISM; Sidney J. Finn; Beverly, Mass.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Oct. 12, 1945; Ser. No. 622,012; 33 Claims; (Cl 89–6).

2,978,961; OVERHEAD COVERAGE GUN MOUNT; Raymond W. Warren; McLean, Va.; assignor to the United States of America as represented by the Secretary of the Navy; Filed Dec. 15, 1953; Ser. No. 398,448; 4 Claims; (Cl. 89–37); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,978,962; SELECTIVE AUTOMATIC FIRE CONVERTER FOR BOLT ACTION RIFLE; Jessie T. Ivy; 523 Henderson St.; Seattle, Wash.; Filed Apr. 20, 1959; Ser. No. 807,645; 6 Claims; (Cl. 89–140).

April 18, 1961

2,979,845; ELECTROMAGNETIC SAFETY SYSTEM FOR FIREARMS; William Christiansen, Jr., 115 N. Division, Lowell, Michigan; Filed December 31, 1958; Serial No. 784,105; 4 Claims. (Cl. 42–70).

2,979,846; PROTECTING GUIDE FOR REPEATING SPORTING GUNS; Jean Fontvielle; Saint Etienne, France; assignor to Manufacture Francaise d'Armes & Cycles de Saint Etienne, France; a joint-stock company of France; Filed Nov. 25, 1958; Ser. No. 776,289; Claims priority, application France; June 19, 1958; 7 Claims; (Cl. 42–71).

2,979,991; RAPID FIRING RECOILLESS BOMB PROJECTING DEVICE; Herbert H. Buschers; Towson; and Pedro C. Medina and Roger W. Wilson, Baltimore, Md.; assignors to The Martin Company; Middle River, Md.; a corporation of Maryland; Filed October 10, 1951; Ser. No. 250,758; 2 Claims; (Cl. 89–1.5).

2,979,992; REVERSIBLE FEEDING MECHANISM; Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 14, 1954; Ser. No. 436,748; 5 Claims; (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

April 25, 1961

2,981,023; **SEALING OF REVOLVER FIRING CHAMBER;** Dimitry B. Sergay; Clawson, Mich.; assignor to General Motors Corporation; Detroit, Michigan; a corporation of Delaware; Filed June 22, 1959; Ser. No. 821,816; 2 Claims; (Cl. 42–59).

2,981,024; **CARTRIDGE LOADER FOR A TUBULAR MAGAZINE;** Eugene Skoff; 3531 S. 57th Court, Cicero, Ill.; Filed Oct. 22, 1959; Ser. No. 847,980; 9 Claims; (Cl. 42–87).

2,981,151; **IGNITION SYSTEM FOR CASELESS ROUNDS IN OPEN BREECH TYPE GUNS;** Thomas Stevenson; 1039 Arthur Ave.; Huntingdon Valley, Pa.; Filed Nov. 18, 1958; Ser. No. 774,790; 5 Claims; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,981,153; **FUEL INJECTION DEVICE;** Elwood J. Wilson, Jr., and Bernard A. Miemeier, Richmond, Va.; assignors to Texaco Experiment Incorporated; a corporation of Virginia; Filed Nov. 14; 1952; Ser. No. 320,438; 14 Claims; (Cl. 89–7).

2,981,154; **SAFETY INTERLOCK FOR MACHINE GUN BARREL;** Patrick E. Sweeney; Baltimore County, Md.; assignor to Aircraft Armaments, Inc.; Cockeysville, Md.; a corporation of Maryland; Filed Jan. 7, 1960; Ser. No. 1,066; 5 Claims; (Cl. 89–14).

2,981,155; **COMPOSITE GUN BARRELS;** Conrad Anthony Parlanti; 34 W. Hill Road; Herne Bay, Kent, England; Filed Mar. 4, 1953; Ser. No. 340,198; 4 Claims; (Cl. 89–16).

2,981,156; **FIRING MECHANISM FOR A SALVO GUN;** David C. Fletcher, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 9, 1956; Ser. No. 621,486; 9 Claims. (Cl. 89–127). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,981,157; **ELECTRICAL CONTROL SYSTEM;** Frank R. Marquardt; Alexandria, Va.; original application Apr. 18, 1950; Ser. No. 156,641; now Patent No. 2,972,826; dated Feb. 21, 1961; Divided and this application June 25, 1957; Ser. No. 667,999; 4 Claims; (Cl. 89–135); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,981,158; **POWER SYSTEM FOR FIREARMS;** David C. Fletcher; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Dec. 7, 1956, Ser. No. 627,081; 5 Claims; (Cl. 89–192); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 2, 1961

2,982,043; **CARTRIDGE CLIP EJECTION MEANS FOR SEMI-AUTOMATIC FIREARMS;** David L. Katz; Longmeadow, Mass.; and Charles E. Lanizzani; Stafford, Conn.; assignors to the United States of America as represented by the Secretary of the Army; Filed July 5, 1960; Ser. No. 40,975; 5 Claims; (Cl. 42–39.5); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,982,044; **SHELL EJECTING MECHANISM FOR FIREARMS OF BREAK-DOWN TYPE;** Harry H. Sefried II, 94 Prospect St.; New Haven, Conn.; Filed Apr. 2. 1959; Ser. No. 803,690; 13 Claims (Cl. 42–47).

2,982,181; **MAGAZINE CARTRIDGE FEED FOR SEMIAUTOMATIC FIREARMS;** Anthony J. Panzica; Northampton, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 4, 1960; Ser. No. 12,875; 5 Claims; (Cl. 89–33); (Granted under Title 35; U.S. Code (1952), sec. 266).

2,982,182; **COMBINED CARTRIDGE CASE RETAINER AND EXTRACTOR;** Ruth B. Felton, Springfield, and Thomas S. Fitzgerald, Chicopee Falls, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed May 27, 1960; Ser. No. 32,487; 6 Claims; (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,982,183; **FIRING RATE CONVERSION MEANS FOR AUTOMATIC FIREARMS;** Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 5, 1958; Ser. No. 733,216; 8 Claims; (Cl 89–129); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,982,184; **ECCENTRIC DRUM MOUNT FOR REVOLVER-TYPE FIREARMS;** William E. Backer; Fulton, Mo.; assignor to the United States of America as represented by the Secretary of the Army; Filed Sept. 23, 1959; Ser. No. 841,911; 2 Claims; (Cl. 89–155).

May 9, 1961

2,983,063; **DESSICATING FLUG FOR BARREL MUZZLE;** Clayton J. Douville; 6121 Zimmerman, NE.; and Gene W. Oswald, 1128 McKee Drive NE., both of Albuquerque, N. Mex.; Filed Feb. 26, 1959; Ser. No. 795.847; 3 Claims; (Cl. 42–1).

2,983,195; **NON-RECOILING GUN;** Ivan Aslund and Folke Gustav Tillander; Bofors, Sweden; assignors to Aktiebolaget Bofors; Bofors, Sweden, a Swedish Company; Filed June 5, 1958; Ser. No. 740,094; Claims priority, application Sweden June 7, 1957; 3 Claims; (Cl. 89–1.7).

2,983,196; **FEEDING MECHANISM FOR GAS PISTON OPERATED GUN;** Paul H. Dixon, Rockford, Ill.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed July 30, 1947; Ser. No. 764,790; 7 Claims; (Cl. 89–33).

2,983,197; **TURRETS, ESPECIALLY FOR ARMORED VEHICLE;** Paul Panhard; Paris, France; assignor to Society Anonyme des Anciens Etablissements Panhard et Levassor; Paris, France; a French society; Filed Jan. 24, 1958; Ser. No. 710,963; Claims priority; application France Jan. 28, 1957; 3 Claims; (Cl. 89–36).

June 20, 1961

2,988,960; **BOMBING NAVIGATIONAL COMPUTER**; Virgil L. Helgeson and Edward J. Loper; Milwaukee, Wis.; assignors to General Motors Corporation; Detroit, Mich.; a corporation of Delaware; Filed July 16, 1956; Ser. No. 598,034; 5 Claims; (Cl. 89–1.5).

2,988,962; **SHELL-HANDLING MECHANISMS FOR GUNS**; Sidney J. Finn; Beverly, Mass.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Feb. 9, 1944; Ser. No. 521,668; 24 Claims; (Cl. 89–33).

2,988,963; **AUTOMATIC FEED MECHANISMS**; William V. Goodhue; Ipswich, Mass.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Apr. 11, 1946; Ser. No. 661,377; 6 Claims; (Cl. 89–33).

June 27, 1961

2,989,815; **AUTOMATIC CHOKE DEVICE FOR SHOTGUNS**; Robert G. Hare; Sharon, Mass.; assignor to Hartford Gun Choke Company, Inc.; Newington, Conn.; a corporation of Connecticut; Filed Aug. 15, 1957; Ser. No. 678,373; 12 Claims; (Cl. 42–79).

2,989,898; **METHOD OF REDUCING SLIDING FRICTION AND ITS APPLICATION TO FIREARMS**; Hans Bucek; Zurich, Switzerland; assignor to Elektrophysikalische Anstalt Bernhard Berghaus; Baduz, Liechtenstein; Filed Nov. 23, 1956; Ser. No. 624,121; Claims priority; application Switzerland Nov. 26, 1955; 3 Claims; (Cl. 89–1).

2,989,900; **STOPPING AND STARTING SYSTEM**; Donald P. Grover; Chicago, Ill.; assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed June 9, 1960, Ser. No. 35,098; 2 Claims; (Cl. 89–12).

July 4, 1961

2,990,752; **LATCHES TO PREVENT OVERTHROW OF RAMMING ROLLS FOR AUTOMATIC GUNS**; William V. Goodhue; East Greenwich, R.I.; and Roland Heeley, Beverly, Mass.; assignors to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Sept. 4, 1947, Ser. No. 772,166; 3 Claims; (Cl. 89–47).

July 11, 1961

2,991,579; **FAST ADJUSTING BIPOD FOR STILL HUNTING AND TARGET SHOOTING**; Clayton H. Lies, 704 S. Estelle; Wichita, Kans; Filed Nov. 4, 1959; Ser. No. 850,894; 3 Claims; (Cl. 42–94).

July 18, 1961

2,992,502; **HANDGUN SAFETY MECHANISM**; Jerry B. Twigg; Bethesda, Md.; (R.F.D. 2, Ellicott City, Md.); Filed June 2, 1959; Ser. No. 817,615; 11 Claims; (Cl. 42–66).

2,992,595; **USE OF ACETYLENE-ETHANE MIXTURE AS PROPELLANT AND EXPLOSIVE**; Thomas B. Owen; Long Beach, Calif; assignor to the United States of America as represented by the Secretary of the Navy; No Drawing; Filed June 29, 1954; Ser. No. 440,307; 4 Claims; (Cl. 89–7). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,992,596; **FLOATING CHAMBER**; Alexander Hammer; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 28, 1959; Ser. No. 830,161; 2 Claims; (Cl. 89–16). (Granted under Title 35, U.S. Code (1952, sec. 266).

2,992,597; **FIREARM FIRING MECHANISM WITH DISCONNECTOR**; Albert J. Lizza; Willimansett, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Dec. 3, 1959; Ser. No. 857,233; 5 Claims; (Cl. 89–145); (Granted under Title 35, U.S. Code (1952), sec. 266).

July 25, 1961

2,993,291; **AUTOMATIC SAFETY MECHANISM FOR ELECTRICALLY CONTROLLED FIRE ARMS**; Charles Rouby, Saint-Etienne, France; assignor to Societe Mederne de Fabrications Mecaniques, Saint-Etienne, France; a French limited-liability company; Original application June 15, 1956; Ser. No. 591,736; Divided and this application July 24, 1959; Ser. No. 829,283; Claims priority; application France Apr. 20, 1956; 2 Claims; (Cl. 42–84).

2,993,414; **AMMUNITION FEED MECHANISM**; Charles K. Woodman, Beverly, Mass.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed June 5, 1946; Ser. No. 674,542; 8 Claims; (Cl. 89–33).

2,993,415; **COMBINED CONTINUOUS LINKLESS SUPPLIER AND CARTRIDGE FEED MECHANISM FOR AUTOMATIC GUNS**; Ello W. Panicci, Torrington, and Harlan C. Clark, Oxford, Conn.; assignors to the United States of America as represented by the Secretary of the Army; Filed July 10, 1959; Ser. No. 826,383; 11 Claims; (Cl. 89–33).

2,993,416; **BALANCING DEVICE FOR FIREARMS HORIZONTALLY PIVOTED OUTSIDE THEIR CENTER OF GRAVITY**; Siegfried Uhl, 111 Ulmerstrasse, Augsburg, Germany; Filed Mar 9, 1959; Ser. No. 798,243; Claims priority; application Germany Mar. 10, 1958; 2 Claims; (Cl. 89–37).

May 16, 1961

2,984,037; **SPRING ADJUSTMENT FOR FIREARMS**; Gary Wilhelm; New Haven, Conn.; assignor to The High Standard Manufacturing Corporation; Hamden, Conn.; a corporation of Connecticut; Filed Feb. 6, 1959; Ser. No. 791,599; 5 Claims; (Cl. 42--69).

2,984,156; **RECOILLESS FIREARM**; Gunnar Filip Edin; Karlskoga, and Folke Gustav Tillander; Bofors, Sweden; assignors to Aktiebolaget Bofors; Bofors, Sweden; a Swedish corporation; Filed Mar. 7, 1960; Ser. No. 13,339; 5 Claims; (Cl. 89–1.7).

May 23, 1961

2,984,924; **EXTRACTOR ASSEMBLY FOR FIREARMS**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed November 24, 1959; Ser. No. 855,247; 4 Claims. (Cl. 42–25); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,984,926; **ADJUSTABLE SHOTGUN CHOKE CONTROL**; Clarence J. Havlin, 2621 W. Woodlawn Ave.; San Antonio, Tex.; Filed Nov. 5, 1959; Ser. No. 851,166; 2 Claims; (Cl. 42–79).

2,985,073; **FUSE-SETTING MECHANISM**; Sidney J. Finn; Beverly, Mass.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Original application Feb. 9, 1944; Ser. No. 521,668; Divided and this application June 16, 1947; Ser. No. 754,856; 18 Claims; (Cl. 89–6).

2,985,074; **FLUTED FLASH HIDER**; C. Walton Musser, 66 McKay St.; Beverly, Mass.; Filed Mar. 28, 1958; Ser. No. 724,778; 3 Claims; (Cl. 89–14); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 30, 1961

2,985,979; **MOISTURE ABSORBING PLUG FOR A FIREARM CHAMBER**; Jerry M. Doyle, 2316 W. 22nd St.; Sioux Falls, South Dakota; Robert H. Brookshier, 4940 N. Olive, Kansas City, Mo.; and Robert L. Montgomery, Kansas City, Mo.; (2914 W. 93rd St.; Leawood, Kans.); Filed Apr. 29, 1960; Ser. No. 25,726; 9 Claims; (Cl. 42–1).

2,985,980; **HANDGUN HARNESS**; Duane K. Broshous, 126 W. Railroad St.; Stockton, Ill.; assignor to one-half to Donald Perry, Stockton, Ill.; Filed Oct. 14, 1959; Ser. No. 846,477; 1 Claim; (Cl. 42–94).

2,986,072; **LIQUID FUEL CATAPULT**; Colin M. Hudson; Arlington, Va.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 19, 1952; Ser. No. 321,534; 1 Claim; (Cl. 89–7). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,986,073; **AUTOMATIC STOP MOTION FOR AUTOMATIC WEAPONS**; Charles Louis Godar, Paris, France; assignor to Etude et Realisation d'Outillage de Precision C.L. Godar et Cle.; Coubevole, France; a corporation of France; Filed Feb. 24, 1959; Ser. No. 795,163; Claims priority; application France Feb. 24, 1958; 1 Claim; (Cl 89–27).

2,986,074; **AMMUNITION FEEDERS FOR AUTOMATIC GUNS**; Paul H. Dixon; Rockford, Ill.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Dec. 9, 1946; Ser. No. 715,079; 8 Claims; (Cl. 89–33).

June 6, 1961

2,986,974; **RAMMING CASE FOR ROCKETS IN RIFLED NAVAL GUNS**; Otto Thalman; Chevy Chase; James L. Walthall, Jr.; Silver Spring; and Gerald L. Hempfling; West Hyattsville, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed Sept. 15, 1958; Ser. No. 761,270; 2 Claims; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

June 13, 1961

2,987,965; **SELF-LOCKING CARTRIDGE CASE FOR FIXED AMMUNITION**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 17. 1958; Ser. No. 722,108; 4 Claims; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,987,966; **MEANS FOR DISASSEMBLING BARRELS FROM FIREARMS**; Arthur R. Meyer; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 10, 1959; Ser. No. 852,154; 4 Claims; (Cl. 89–14); (Granted under Title 35; U.S. Code (1952), sec. 266).

2,987,967; **FIREARM WITH PISTON HAVING SPRING-PRESSED INERTIA VALVE**; Rolf H. Wild; Hamden, and George Dmitrieff, Bethany, Conn.; assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Feb. 27, 1959; Ser. No. 796,087; 2 Claims; (Cl. 89–193).

2,987,968; **FIREARM GAS PISTON WITH POWER CAVITY AND INERTIA VALVE**; Stefan K. Janson, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virignia; Filed Sept. 28, 1959; Ser. No. 842,907; 1 Claim; (Cl. 89–193).

August 1, 1961

2,994,249; **RECOILLESS GUN FOR LIGHTWEIGHT PROPELLANT CHARGE**; George Schecter, Somerton, Pa.; and C. Walton Muser, Beverly, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed May 8, 1958; Ser. No. 734,065; 1 Claim; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952). sec. 266).

August 8, 1961

2,994,981; **HAMMER SAFETY LOCK FOR FIREARMS**; Carl E. Carrigan, 715 Bossier St.; Natchitoches, La.; Filed August 1, 1960; Ser. No. 46,686; 1 Claim; (Cl. 42–66).

August 15, 1961

2,995,987; **ALUMINUM-CHLORINE DETONATOR CATALYST FOR HYDROCARBON PROPELLANT**; John A. Fitzpatrick, Washington, D.C.; assignor to the United States of America as represented by the Secretary of the Navy; Filed June 18, 1954; Ser. No. 437,898; 5 Claims; (Cl. 89–7). (Granted under Title 35, U.S. Code (1952), sec. 266).

2,995,988; **DUAL RATE SEAR MECHANISM**; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 2, 1960; Ser. No. 66,890; 6 Claims; (Cl. 89–129); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 22, 1961

2,996,957; **HYDRAULICALLY OPERATED BREECH MECHANISM**; Paul I. Evans, Livermore, Calif.; assignor to the United States of America as represented by the Secretary of the Army; Filed Mar. 5, 1959; Ser. No. 797,826; 5 Claims; (Cl. 89–17).

August 29, 1961

2,997,801; **CHAMBER PLUGGING DEVICE FOR FIREARMS**; Lewis C. Robbins, 2918 28th Street N.W., Washington, D.C.; Filed November 26, 1958; Ser. No. 776,480; 2 Claims. (Cl. 42–1).

2,997,803; **REMOVABLE MAGAZINE UNIT FOR BOLT ACTION RIFLE**;Clyde M. Florence, 204 E. Heron St.; Aberdeen, Wash.; Filed June 19, 1959; Ser. No. 821,403; 1 Claim; (Cl. 42–18).

2,997,923; **AMMUNITION FEED MECHANISM**; Howard O. Kempton; Columbus, Ohio; assignor to Curtiss-Wright Corporation; a corporation of Delaware; Filed Nov. 28, 1947; Ser. No. 788,385; 20 Claims; (Cl. 89–33).

2,997,924; **FIREARM WITH ROTARY MAGAZINE AND PIVOTING REAR BARREL SECTION**; Waldo E. Rosebush; 411 E. Washington St.; Appleton, Wis.; Filed Aug. 5, 1960; Ser. No. 47,724; 11 Claims; (Cl. 89–155).

September 5, 1961

2,998,755; **TRAVERSELY SWINGING GUN BREECH WITH OBTURATING SEAL**;.Robert J. Thierry, Averill Park, N. Y., assignor to the United States of America as represented by the Secretary of the Army; Filed February 1, 1960; Ser. No. 6,076; 6 Claims. (Cl. 89–26); (Granted under Title 35, U.S. Code (1952), sec. 266).

2,998,756; **RAMMING DEVICE FOR FIREARMS**; Carl Mauritz Christiansson; Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed Dec. 11, 1958; Ser. No. 779,641; Claims priority, application Sweden Dec. 14, 1957; 4 Claims; (Cl. 89–47).

2,998,757; **CONTROL MECHANISM FOR AUTOMATIC FIREARMS WITH REVOLVER DRUM**; Fritz Herlach and Erwin Hepperle; Zurich, Switzerland; assignors to Machine Tool Works; Oerlikon; Administration Company, Zurich-Oerlikon; Switzerland; a company of Switzerland; Filed Mar. 22, 1951; Ser. No. 216,881; Claims priority, application Switzerland Aug. 23, 1950; 1 Claim; (Cl. 89–155).

2,998,758; **REVOLVING CAGE GUN WITH A PLURALITY OF BARRELS AND REMOVABLE CHAMBERS**; Herve J. Ouellette; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 19, 1957; Ser. No. 666,788; 4 Claims; (Cl. 89–155). (Granted under Title 35, U.S. Code (1952), sec. 266).

September 12, 1961

2,999,327; **SINGLE TRIGGER MECHANISM FOR DOUBLE BARRELLED SHOT-GUNS**; John Eyton Orr; 42 Broad Road; Acocks Green; Birmingham, England; Filed Aug. 24, 1959; Ser. No. 835,522; 8 Claims; (Cl. 42–42).

September 19, 1961

3,000,126; **CARTRIDGE-GUIDING MECHANISM**; Russell S. Robinson; Short Beach, Conn.; (124 Via Yella, Lido Isle, Newport Beach, Calif.); Filed Feb. 4, 1953; Ser. No. 335,111; 21 Claims; (Cl. 42–18).

3,000,265; **CARTRIDGE FEEDING MECHANISM FOR FIREARMS:**; Russell S. Robinson, Short Beach, Conn.; (124 Via Yella Lido Isle, Newport Beach, Calif.); Filed Oct. 29, 1952; Ser. No. 317,484; 7 Claims; (Cl. 89–33).

3,000,266; **SEMI-AUTOMATIC AND FULL-AUTOMATIC OPERATION OF GAS-OPERATED FIREARM WITH SLIDABLE BARREL AND SLIDABLE RECEIVER**; Oscal Bilbao Varona; 17 N. Road Cuabo, Quezon City; Phillipine Republic; Filed July 29, 1959; Ser. No. 830,399; 5 Claims; (Cl. 89–140)

3,000,267; **BREECH BOLT OPERATING MECHANISM**; Russell S. Robinson; Short Beach, Conn.; (124 Via Yella, Lido Isle, Newport Beach, Calif.); Filed Sept. 24, 1952; Ser. No. 311,215; 19 Claims; (Cl. 89–169).

3,000,268; **TOGGLE LOCK FOR BREECH BOLT**; Russell S. Robinson, Short Beach, Conn.; (124 Via Yella, Lido Isle, Newport Beach, Calif.); Filed Sept. 12, 1952; Ser. No. 309,193; 13 Claims; (Cl. 89–189).

3,000,269; **CARBINE STABILIZER**; Oscar Bilbao Varona and Olivio Bilbao Varona, both of 17 N. Road Cubao, Quezon City; Phillipine Republic; Filed July 29, 1959; Ser. No. 830,401; 6 Cliams; (Cl. 89–198).

September 26, 1961

3,001,312; **FIREARM BUTT PLATE WITH LIQUID RECOIL ABSORBING DEVICE**; Clark S. Campbell; Ilion, N.Y.; assignor to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed Mar. 24, 1958; Ser. No. 723,225; 3 Claims; (Cl. 42–74).

3,001,453; **DEVICE FOR JETTISONING FIRED CASES FROM AUTOMATIC FIREARMS**; Richard H. Colby; South Hadley; and Raymond W. Hegarty; Springfield, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed Sept. 29, 1959; Ser. No. 843,317; 11 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

October 10, 1961

3,003,274; **CARTRIDGE FEED SYSTEM**; Charles H. Morse; Herkimer, and Homer W. Young, Ilion, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed Dec. 8, 1959; Ser. No. 858,099; 3 Claims; (Cl. 42–17).

3,003,399; **LOCKAGE OF BREECH OF MORTAR BARREL TO COUNTERPLATE**; Hans O. Donner; Hameenkatu 14, Tampore, Finland; Filed Mar. 27, 1959; Ser. No. 802,382; 4 Claims; (Cl. 89–37).

3,003,400; **TAKE-DOWN ASSEMBLY FOR A FIREARM WITH A GAS PISTON**; James H. Johnson; New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed Jan. 21, 1960; Ser. No. 3,776; 6 Claims; (Cl. 89–191).

October 17, 1961

3,004,361; **COMPOSITE LIGHTWEIGHT BARREL WITH PREDETERMINED THERMAL CHARACTERISTICS**; Alexander Hammer; Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Oct. 8, 1959; Ser. No. 845,293; 3 Claims; (Cl. 42–76); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,004,475; **ROCKET GUN**; Irwin R. Barr; Kingsville; Joseph N. Bond, Baltimore; Bertram W. Gore, Jr., Owings Mills; and Nicholas J. La Costa, Kingsville, Md.; assignors to Aircraft Armaments, Inc.; Baltimore, Md.; a corporation of Ohio; Filed April 28, 1953; Ser. No. 351,667; 8 Claims; (Cl. 89–1.7).

October 24, 1961

3,005,279; **BOLT ACTION RIFLE WITH GAS DEFLECTING MEANS**; Nicholas L. Brewer, deceased, late of Tarpon Springs, Fla.; by Margaret W. Brewer, executrix, Tarpon Springs, Fla.; assignor to Savage Arms Corporation; Chicopee Falls, Mass.; a corporation of Delaware; Filed Nov. 20, 1958; Ser. No. 775,143; 10 Claims; (Cl. 42–18).

3,005,386; **CARTRIDGE CASE EJECTING MECHANISM**; C. Walton Musser, 66 McKay St.; Beverly, Mass.; Filed Jan. 22, 1960; Ser. No. 4,161; 4 Claims; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 31, 1961

3,006,096; **SAFETY MECHANISM FOR SLIDE ACTION REPEATING FIREARM**; Frank T. Green and Wilfred I. Smith; Haydenville, Mass.; assignors to Noble Manufacturing Co., Inc.; Haydenville, Mass.; a corporation of Massachusetts; Filed June 26, 1959; Ser. No. 823,063; 1 Claim; (Cl. 42–70).

3,006,254; **SELF-ENERGIZING BREECH SEAL FOR GUNS**; Robert J. Thierry, Averill Park, M.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed Feb. 17, 1960; Ser. No. 9,402; 4 Claims; (Cl. 89–26). (Granted under Title 35, U.S. Code (1952), sec. 266).

November 7, 1961

3,007,271; DEVICE FOR THROWING GRENADES BY MEANS OF FIREARMS; Edgar William Brandt, Geneva, Switzerland; assignor to Anstalt fur die Entwickling von Erfindungen und Gewerblichen Anwendungen Energa; Vaduz, Liechtenstein; Filed Feb. 20, 1959; Ser. No. 794,563; Claims priority, application Switzerland Mar. 28, 1958; 5 Cliams; (Cl. 42–1).

3,007,272; RECOIL PAD FOR A GUN STOCK; Frank A. Pachmayr; 1220 S. Grand Ave.; Los Angeles, Calif.; filed Mar. 30, 1959; Ser. No. 802,928; 2 Claims; (Cl. 42–74).

November 14, 1961

3,008,258; FIREARM AND CARTRIDGE THEREFOR; David A. Johnson; Box 66, Malin, Oreg.; Filed June 15, 1960; Ser. No. 36,225; 2 Claims; (Cl. 42–14).

3,008,378; POWDER GRAIN BAFFLE FOR RECOILLESS RIFLE; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Apr. 28, 1960; Ser. No. 25,490; 1 Claim; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,008,380; WATERPROOF GUN COVER; Richard T. Cowley, Ellicott City, Md.; assingor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed Sept. 30, 1959; Ser. No. 843,606; 4 Claims; (Cl. 89–37.5).

November 21, 1961

3,009,394; AMMUNITION LINK; Ewald A. Kamp, Chicago, and William L. Kuivinen, Mount Prospect, Ill.; assignors to the United States of America as represented by the Secretary of the Air Force; Filed July 12, 1960; Ser. No. 42,452; 5 Claims; (Cl. 89–35).

3,009,395; FIELD PIECE WITH SWINGABLY MOUNTED WHEELS; Edgar William Brandt, Geneva, Switzerland; assignor to Anstalt fur die Entwicklung von Erfindungen und gewerblichen Anwendungen Energa, a corporation of Vaduz, Liechtenstein; Filed June 13, 1957; Ser. No. 665,429; Claims priority, application Switzerland June 19, 1956; 2 Claims; (Cl. 89–40).

3,009,396; GAS PISTON OPERATED AUTOMATIC GUN; Paul H. Dixon; Rockford, Ill.; assignor to United Shoe Machinery Corporation; Flemington, N.J.; a corporation of New Jersey; Filed Sept. 24, 1947; Ser. No. 775,844; 1 Claim; (Cl. 89–191).

November 28, 1961

3,010,237; QUICK RELEASE SEAR FOR LIGHT MACHINE GUNS; Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Oct. 5, 1960; Ser. No. 60,759; 5 Claims; (Cl. 42–69); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,010,369; DUAL FIRING TRIGGER AND GUN AIMING MECHANISM; C. Walton Musser, Beverly, Mass.; and Albert Benditt, Philadelphia, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed Jan. 22, 1960; Ser. No. 4,159; 5 Claims; (Cl. 89–27). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,010,370; CONTROLLED BURST FIRING MECHANISM; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; 16 Claims; (Cl. 89–129); (Granted under Title 35, U.S. Code (1952), sec. 266).

December5, 1961

3,011,282; FIRING MECHANISM FOR FIREARMS; Harry H. Sefried II; New Haven, Conn.; assignor to The High Standard Manufacturing Corporation; Hamden, Conn.; a corporation of Connecticut; Filed Jan. 19, 1959; Ser. No. 787,489; 4 Claims; (Cl. 42–69).

3,011,283; REINFORCED PLASTIC RIFLE STOCK; James S. Lunn, 105 Cathedral Ave.; Hempstead, N.Y.; Harry T. Douglas, Middle Hollow Road; Lloyd Harbon, Huntington, N.Y.; and Vagn Vernegaard, Sheffield Lane, Northport, N.Y.; Filed Mar. 9, 1950; Ser. No. 797,977; 4 Claims; (Cl. 42–71).

3,011,404; LIQUID PROPELLANT SQUEEZE-BORE GUN WITH DEFORMABLE PROJECTILE SABOT; Charles R. Russell, 1637 Roberts Land, Falls Church, Va.; Filed Jan. 30, 1950; Ser. No. 141,311; 9 Claims; (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,001,407; GUNS OR MORTARS; Dudley van Koningsveld, Enfield, England; assignor to Minister of Supply in Her Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, London, England; Filed July 16, 1958; Ser. No. 748,922; Claims priority; application Great Britain July 29, 1957; 4 Claims; (Cl. 89–17).

3,011,408; SHELL CASE EJECTOR CHUTE; William W. Brothers, Jr.; and James E. Ellard, Jr.; Eglin Air Force Base, Fla.; assignors to the United States of America as represented by the Secretary of the Air Force; Filed Nov. 19, 1959; Ser. No. 854,202; 4 Claims; (Cl. 89–33).

3,011,409; FIREARM SUPPORTING MEANS; C. Walton Musser, 66 McKay St.; Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Apr. 20, 1960; Ser. No. 23,585; 5 Claims; (Cl. 89–40); (Granted under Title 35, U.S. Code (1952), sec. 266).

December 12, 1961

3,012,349; RIFLE EQUIPPED WITH A GRENADE THROWING DEVICE AND AN AIMING SCALE; Nicolaus Donatsch, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques, S.A., Geneva, Switzerland; Filed Sept. 28, 1959; Ser. No. 842,830; Claims priority, application Luxembourg Oct. 3, 1958; 9 Claims; (Cl. 42–1).

3,012,350; BENCH REST PEDESTAL; Frank E. Wold, P.O. Box 55, Plamdale, Calif.; Filed Feb. 2, 1959; Ser. No. 790,753; 9 Claims; (Cl. 42–94).

3,012,479; FIRING MECHANISM FOR AUTOMATIC FIREARMS; Leslie Ernest Ruffell; Dagenham, England; assignor to Sterling Engineering Company Limited; Dagenham, England; a British Company; Filed Apr. 18, 1958; Ser. No. 729,295; Claims priority; application Great Britain Apr. 30, 1957; 8 Claims; (Cl. 89–142).

December 19, 1961

3,013,355; FIREARM BREECH BOLT MECHANISM WITH A BOLT STOP; Roy E. Weatherby; 2781 Firestone Blvd.; South Gate, Calif.; Filed Feb. 11, 1959; Ser. No. 792,519; 7 Claims; (Cl. 42–16).

3,013,472; HIGH VELOCITY MULTI-STAGE GUNS; Henry Kahn, Levittown; William J. Kroeger, Philadelphia; and William Dittrich, Abington, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed Dec. 4, 1958; Ser. No. 778,268; 1 Claim; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

December 26, 1961

3,014,303; BREECH BOLT WITH EXTRACTOR AND MAGAZINE-RECEIVER ASSEMBLY; Richard L. Brown, North Branford; and Edward L. Morrow, Bridgeport, Conn.; assignors to Olin Mathieson Chemical Corporation; Filed Jan. 13, 1958; Ser. No. 708,731; 3 Claims; (Cl. 42–25).

3,014,304; INERTIA INJECTOR; Richard L. Brown, North Branford; Edward L. Morrow, Bridgeport; and Edwin S. Vartanian, North Haven, Conn.; assignors to Olin Mathieson Chemical Corporation; Filed Jan. 13, 1958; Ser. No. 708,732; 3 Claims; (Cl. 42–25).

January 2, 1962

3,015,254; **STABILIZED CONTROL CONTROL MECHANISM FOR A GUN MOUNTED ON A TURRET**; Ward Leathers and George S. Di Monico, Brooklyn, and Lawrence Bruehi, New York, N.Y.; assignors to International Business Machines Corporation, New York, N.Y.; a corporation of New York; Filed Dec. 29, 1945; Ser. No. 638,394; 3 Claims; (Cl. 89–41).

January 9, 1962

3,015,993; **SELECTIVE FIRE CONVERTER AND RATE REDUCER**; Attilio Mario Franchi; Brescia, Italy; assignor to Soc. p. Az. Luigi Franchi; Brescia, Italy; Filed July 27, 1960; Ser. No. 45,711; Claims priority; application Italy Aug. 5, 1959; 4 Claims; (Cl. 89–131).

January 16, 1962

3,016,645; **SINGLE TRIGGER MECHANISM FOR A TWO-BARREL GUN**; Howard L. Miller and Irvin K. Miller, both of RD. 1, Millersburg, Pa.; Filed Apr. 19, 1960; Ser. No. 23,233; 5 Claims; (Cl. 42–42).

3,016,646; **HAMMER ASSEMBLY FOR A PISTOL**; Walter H. B. Smith; deceased, late of New York, N.Y., by Katherine B. Groves, executrix; 150 W. 58th Street, New York, N.Y.; Filed Dec. 2, 1959; Ser. No. 856,750; 18 Claims; (Cl. 42–69).

3,016,802; **TRIPOD GUN RESTS**; Anton Grunenberg, 207 Duncan Ave., Oak Hill, W. Va.; Filed Aug. 1, 1958; Ser. No. 752,649; 3 Claims; (Cl. 89–40).

January 23, 1962

3,017,807; **ROTARY PISTON CHARGER-BRAKE MECHANISM**; Donald P. Grover, Chicago, Ill.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 24, 1960; Ser. No. 38,686; 7 Claims; (Cl. 89–12).

3,017,808; **LONGITUDINAL ALIGNMENT OF CARTRIDGES IN A CARTRIDGE BELT BEFORE ENTERING THE BREECH OF A GUN**; Siegfried Uhl, Augsburg, Germany; assignor to Keller and Knappich G.m.b.H.; Augsburg, Germany; a corporation of Germany; Filed Mar 9, 1960; Ser. No. 13,813; Claims priority; application Germany Mar. 11, 1959; 6 Claims; (Cl. 89–33).

January 30, 1962

3,018,576; **LOCKING SAFETY DEVICE FOR FIREARMS**; William H. Riechers, R.D. 2, Box 399, Endicott, N.Y.; Filed Jan. 4, 1961; Ser. No. 80,663; 4 Claims; (Cl. 42–1).

3,018,577; **TUBULAR MAGAZINE FIREARM WITH LOADING PORT IN SIDE OF MAGAZINE**; Paul A. La Violette, Jr.; Hamden, Conn.; assignor to The High Standard Manufacturing Corporation; Hamden, Conn.; a corporation of Connecticut; Filed Oct. 20, 1959; Ser. No. 847,494; 2 Claims; (Cl. 42–6).

3,018,578; **PISTOL TO BE WORN ON THE WRIST**; Edward T. Hill, 2221 S. Hoover St.; Los Angeles, 7, Calif.; Filed Dec. 7, 1959; Ser. No. 857,940; 5 Claims; (Cl. 42–14).

3,018,693; **FUSE-SETTING MECHANISM**; Harry B. Patten, Beverly, Mass.; assignor to United Shoe Machinery Corporation, Flemington, N.J.; a corporation of New Jersey; Filed Apr. 4, 1946; Ser. No. 659,548; 16 Claims; (Cl. 89–6).

3,018,694; **RECOIL ABSORBING MECHANISM FOR FIREARMS**; Val A. Browning, Ogden, Utah; assignor to Browning Industries, Inc.; Ogden, Utah; a corporation of Utah; Filed May 7, 1959; Ser. No. 811,699; 8 Claims; (Cl. 89–159).

February 6, 1962

3,019,542; **CARTRIDGE MAGAZINE CONVERSION**; Atlee G. Manthos, Arlington Heights, Ill.; (Box 2401, Spokane International Airport, Spokane, Wash.); Filed June 13, 1958; Ser. No. 741,818; 4 Claims; (Cl. 42–18).

3,019,543; **RECOIL ABSORBER FOR A FIREARM**; Alfred Ducharme, Bald Hill Trailer Camp, West Warwick, R.I.; Filed July 1, 1959; Ser. No. 824,235; 2 Claims; (Cl. 42–74).

3,019,711; **CONTROL SYSTEMS FOR POSITIONING OBJECTS HAVING HIGH INERTIA**; Francis M. Bailey, Scotia, N.Y.; and Eugene B. Canfield, Pittsfield, Mass.; assignors to General Electric Company; a corporation of New York; Filed Dec. 26, 1956; Ser. No. 630,700; 13 Claims; (Cl. 89–41).

February 13, 1962

3,020,662; **REPEATING MAGAZINE RIFLE WITH ROTATABLE AND FORWARDLY MOVABLE BARREL**; Adam Merkel, 16 Fraunauses Wiebelsbach, Kreis Dieburg (Odenwald); Hessen, Germany; Filed Jan. 9, 1959; Ser. No. 785,923; 3 Claims; (Cl. 42–11).

3,020,663; **SAFETY TRIGGER LOCK FOR FIREARMS**; Clarence W. Newson, 854 W. 3rd North St.; Salt Lake City 16, Utah; Filed May 5, 1960; Ser. No. 27,044; 2 Claims; (Cl. 42–70).

3,020,807; **CONTROL DEVICE FOR GAS OPERATED FIREARM**; Ellis W. Hallston, Illon, N.Y.; and Lowell E. Huffman, Neward, Del.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed Apr. 4, 1958; Ser. No. 726,518; 6 Claims; (Cl. 89–193).

February 20, 1962

3,021,633; COMBINATION MUZZLE BRAKE AND GRENADE LAUNCHER FOR PORTABLE FIREARMS; Pier Carlo Beretta; Via Siepi 6, Gardone V.T.; Brescia, Italy; Filed June 30, 1960; Ser. No. 40,495; Claims priority; application Italy Apr. 2, 1960; 4 Claims; (Cl. 42–1).

3,021,634; FIREARMS EXTRACTOR-EJECTOR ASSEMBLY; James H. Johnson, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed Apr. 14, 1960; Ser. No. 22,156; 1 Claim; (Cl. 42–25).

3,021,760; SHEET METAL NOZZLE; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 13, 1960; Ser. No. 2,314; 1 Claim; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,021,761; DEVICE FOR BELT-FED GUNS; Folke Gustav Tillander; Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed Jan. 20, 1960; Ser. No. 3,606; Claims priority; application Sweden Jan. 31, 1959; 5 Claims; (Cl. 89–33).

3,021,762; DEVICE FOR FEEDING ROUNDS OF AMMUNITION FROM A MAGAZINE TO THE RAMMING POSITION OF A GUN; Karl Olof Soderqvist; Karlskoga, Sweden; assignor to Aktiebolaget Bofors; Bofors, Sweden; a company of Sweden; Filed June 11, 1958; Ser. No. 741,414; Claims priority; application Sweden June 14, 1957; 4 Claims; (Cl. 89–33).

3,021,763; MECHANISM FOR CONVERTING A RIFLE FROM SEMI-AUTOMATIC TO AUTOMATIC FIRING; Pier Carlo Beretta, Via Siepi 6, Gardone; Valtrompia, Italy; Filed Apr. 6, 1960; Ser. No. 20,394; Claims priority; application Italy May 23, 1959; 2 Claims; (Cl. 89–140).

February 27, 1962

3,022,596; SAFETY DEVICE FOR TRIGGER GUARD; Colbert H. Cannon, Rte. 1, Box 334; Gold Hill, Oreg.; Filed May 11, 1960; Ser. No. 28,282; 1 Claim; (Cl. 42–1).

3,022,598; SAFETY DEVICE FOR A REVOLVER; Hugo M. Wikstrom, Port Washington, N.Y.; (60 E. 42nd Street, New York, N.Y.); Filed Sept. 14, 1960; Ser. No. 56,019; 1 Claim; (Cl. 42–66).

March 5, 1962

3,023,527; FIREARM HAVING RECEIVER BEARING SURFACES OF SYNTHETIC RESINOUS MATERIAL; Wayne E. Leek, Ilion, and Charles H. Morse, Herkimer, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Continuation of abandoned application Ser. No. 557,473; Jan. 5, 1956; This application Dec. 15, 1958; Ser. No. 780,573; 19 Claims; (Cl. 42–71).

3,023,528; FIREARM WITH ELECTRICALLY ACTUATED FIRING MEANS; Charles Rouby, Saint-Etienne, France; assignor to Societe Moderne de Fabrications Mecaniques; Saine-Etienne, France; a French company; Filed Apr. 18, 1960; Ser. No. 22,768; Claims priority; application France Apr. 24, 1959; 4 Claims; (Cl. 42–84).

3,032,674; WHEELED GUN CARRIAGE; John Nils Emanuel Sundstrom; Sundsvall, Sweden; assignor to Forsvarets fabriksstyrelse (Directorate of Defence Factories); Stockholm, Sweden; Filed Mar. 23, 1959; Ser. No. 801,213; Claims priority, application Sweden Dec. 17, 1958; 1 Claim; (Cl. 89–40).

March 13, 1962;

3,024,559; TRIGGER AND SAFETY MECHANISM FOR FIREARMS; Roy E. Weatherby, 2781 Firestone Blvd.; South Gate, Calif.; Filed Sept. 17, 1959; Ser. No. 840,607; 2 Claims; (Cl. 42–70).

March 18, 1962

3,024,704; ARMOURED TANK; Georges Even, 3 Blvd. Victor, Paris, France; Filed May 13, 1957; Ser. No. 658,605; Claims priority, application France Aug. 13, 1951; 4 Claims; (Cl. 89–36).

3,024,705; RAMMER; Robert A. Rosenblum; Stokie, Ill.; assignor by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed Jan, 26, 1960; Ser. No. 4,835; 1 Claim; (Cl. 89–47).

3,024,706; GAS OPERATED FIREARM WITH A MOVABLE GAS CYLINDER FUNCTIONING AS AN INERTIA MEMBER; Rolf H. Wild; Hamden, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed Aug. 24, 1959; Ser. No. 835,763; 4 Claims; (Cl. 89–193).

March 20, 1962

3,025,765; SEGMENTED RING-TYPE REFRACTORY METAL LINERS FOR GUNS; Robert F. Baker, Butler, N.J.; assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa.; a corporation of Pennsylvania; Filed Jan. 30, 1952; Ser. No. 268,974; 2 Claims; (Cl. 89–16).

3,025,766; CARTRIDGE BELT FOR AUTOMATIC WEAPONS; Hartmut Menneking; Dusseldorf, Germany, assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed Oct. 6, 1959; Ser. No. 844,687; Claims priority; application Germany Oct. 7, 1958; 2 Claims; (Cl. 89–35).

March 27, 1962

3,026,642; **FIREARM ACTUATING BUCKLE**; John W. Ryan, 11027 Cashmere St.; Bel-Air, Calif.; Filed May 14, 1959; Ser. No. 813,272; 10 Claims; (Cl. 42–1).

3,026,775; **RECOILLESS RIFLE WITH A VENA CONTRACTA ORIFICE**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 13, 1959; Ser. No. 826,888; 3 Claims; (Cl. 89–1.7).; (Granted under Title 35, U.S. Code (1952), sec. 266).

3,026,776; **LATCH TYPE CARTRIDGE LINK**; Nicholas D. Kintzer; Watertown, Conn.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 21, 1960; Ser. No. 37,819; 8 Claims; (Cl. 89–35).

3,026,777; **AUTOMATIC FIRING MECHANISM**; Thomas R. Wooderson III; 609 S. Campbell Road; Royal Oak, Mich.; Filed May 2, 1958; Ser. No. 733,249; 9 Claims; (Cl. 89–149).

April 3, 1962

3,027,672; **FIREARM WITH ALUMINUM ALLOY RECEIVER**; George C. Sullivan, 3085 Lake Hollywood Drive; Hollywood, Calif.; Continuation of application Ser. No. 652,601; Spr. 12, 1957; This application April 26, 1962; Ser. No. 105,812; 14 Claims; (Cl. 42–16).

3,027,673; **LOW BARREL REVOLVER**; John R. Oliver, Boston, Mass.; (3371 Main Road, Tiverton, R.I.); Filed March 26, 1957; Ser. No. 648,569; 8 Claims; (Cl. 42–65).

3,027,674; **SAFETY LOCK FOR REVOLVERS**; James F. Mahan; 21 Standish St.; Cambridge, Mass.; Filed June 9, 1959; Ser. No. 819,055; 7 Claims; (Cl. 42–66).

3,027,808; **INTERVALOMETER**; Donald S. Bayley, Bedford Village; Philip A. White, White Plains; and Carl F. Schaefer, Port Washington, N.Y.; assignors by mesne assignments, to United Aircraft Corporation, East Hartford, Conn.; a corporation of Delaware; Filed May 12, 1950; Ser. No. 161,634; 10 Claims; (Cl. 89–1.5).

3,027,809; **RECOILLESS RIFLE**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 22, 1960; Ser. No. 4,160; 1 Claim; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,027,810; **TURRET MOUNT**; Hans F. Mueller, Playa Del Ray, Calif., assignor to the United States of America as represented by the Secretary of the Army; Filed July 23, 1958; Ser. No. 750,517; 11 Claims; (Cl. 89–37).

3,027,811; **FIRE CONTROL MECHANISM FOR RECIPROCATING BOLT FIREARMS**; Homer W. Young, Ilion, N.Y.; assignor to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed Apr. 29, 1958; Ser. No. 731,811; 7 Claims; (Cl. 89–145).

April 17, 1962

3,029,540; **GUN CHOKE MOUNTING APPARATUS**; Frank A. Pachymar, Glendale, Calif.; (1220 S. Grand Ave., Los Angeles, Calif.) Filed July 25, 1960, Ser. No. 45,057; 11 Claims; (Cl. 42–79).

3,029,705; **CLOSURE MEMBER FOR THE FIRING CHAMBER OF AN EXPLOSIVELY-OPERATED DEVICE**; William F. Broske, Camp Hill, Pa.; assignor to AMP Incorporated, Harrisburg, Pa.; Filed Aug. 18, 1959; Ser. No. 834,428; 1 Claim; (Cl. 89–17).

3,029,706; **DEVICE FOR GUIDING AN AMMUNITION BELT**; Hermann Wey; Wallisellen, Zurich, Switzerland; assignor to Machine Tool Works Oerlikon, Administration Company; Zurich-Oerlikon, Switzerland; a company of Switzerland; Filed Mar. 25, 1959; Ser. No. 801,934; Claims priority; application Switzerland Apr. 3, 1958; 7 Claims; (Cl. 89–33).

3,029,707; **RAMMING DEVICE FOR RAMMING A ROUND OF AMMUNITION**; Carl Mauritz Christiansson; Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a Swedish company; Filed June 19, 1958; Ser. No. 743,095; Claims priority; application Sweden June 20, 1957; 6 Claims; (Cl. 89–47).

3,029,708; **TRIGGER MECHANISM FOR AUTOMATIC FIREARMS**; Felice Marchislo, 70 Corso Massimo d'Azeglio; Turin, Italy; Filed Feb. 15, 1961, Ser. No. 89,539; Claims priority; application Italy Feb. 22, 1960; 2 Claims; (Cl. 89–131).

3,029,709; **DUAL ADVANCED WARNING AND CUTOUT SWITCH**; Saul Roman; Brooklyn, N.Y.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Navy; Filed April 7, 1960; Ser. No. 20,785; 2 Claims; (Cl. 89–134).

April 24, 1962

3,030,722; **RECEIVER WITH LID COVERING THE EJECTION SLOT**; Jessie T. Ivy, 523 Henderson St.; Seattle, Wash.; Filed April 20, 1959; Ser. No. 807,555; 1 Claim; (Cl. 42–16).

3,030,723; **FIRING MECHANISM FOR A GAS OPERATED REVOLVER**; Jessie T. Ivy, 523 Henderson St.; Seattle, Wash.; Filed Aug. 3, 1959; Ser. No. 831,288; 4 Claims; (Cl. 42–65).

3,030,724; **MAGAZINE CHARGER WITH INWARDLY RAISED RIBS**; James Curran, Cheadle Hulme, England; assignor to Thomas French & Sons Limited, a corporation of Great Britain; Filed Apr. 13, 1960; Ser. No. 22,043; Claims priority; application Great Britain Apr. 14, 1959; 3 Claims; (Cl. 42–88).

3,030,864; SELF-EJECTING BREECH; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 3, 1960; Ser. No. 26,655; 3 Claims; (Cl. 89–1.7). (Granted under Title 35, U.S. Code (1952), sec. 266).

May 1, 1962

3,031,786; FINGER REST ATTACHMENT FOR FIREARMS; Robert Swan, 4978 Wawona St.; Los Angeles, Calif.; Filed Feb. 24, 1959; Ser. No. 795,029; 2 Claims; (Cl. 42–1).

3,031,787; SAFETY DEVICE FOR FIREARMS; Sherman C. Womble, Jr.; Stockton, Calif.; assignor to Delta Dynamics Corporation, Stockton, Calif.; a corporation of California; Filed Oct. 26, 1959; Ser. No. 848,794; 7 Claims; (Cl. 42–70).

3,031,931; EXPENDABLE SCREW MORTAR; Norman K. Turnbull, Pitman, N.J.; and Henry Kahn, Levittown, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed Dec. 4, 1958; Ser. No. 778,266; 3 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,031,933; EXPLOSIVE LINEAR ACCELERATION; Werner K. Kern, Tallahassee and Fay E. Null, Shalimar, Fla.; Filed Nov. 4, 1960; Ser. No. 67,444; 10 Claims; (Cl. 89–8). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,031,934; LATCH TYPE CARTRIDGE LINK; Harlan C. Clark, Oxford, Conn.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed July 20, 1960; Ser. No. 44,237; 4 Claims; (Cl. 89–35).

May 8, 1962

3,032,907; CARTRIDGE CLIP; George F. Parker, Ottawa, Ontario, Canada; assignor to Her Majesty the Queen, in Right of Canada, as represented by the Minister of National Defence; Filed Nov. 18, 1959; Ser. No. 853,822; 2 Claims; (Cl. 42--88).

3,033,085; TEMPERATURE COMPENSATING SYSTEM FOR HYDROPNEUNATIC EQUILIBRATOR; Donald E. Witkin, Levittown, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 28, 1959; Ser. No. 789,760; 3 Claims; (Cl. 89–37).

May 15, 1962

3,034,243; LEVER OPERATED RIFLE WITH FIRING MECHANISM ON THE LEVER; William B. Morris, Rte. 1, Box 186, Hurst, Texas; Original application Nov. 9, 1956; Ser. No. 621,245; now Patent No. 2,961,791; dated Nov. 29, 1960; Divided and this application Oct. 6, 1960; Ser. No. 60,931; 3 Claims; (Cl. 42–70).

3,034,244; GUN BARREL WITH A LAYER OF RADIOACTIVE MATERIAL; Warren J. Helman, 1765 Pacific Avenue; San Francisco, Calif.; No Drawing; Filed Aug. 2, 1954; Ser. No. 447,466; 1 Claim; (Cl. 42–76). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,034,407; BARREL SAFETY LATCH; Burns Darsie, Rockford, Ill.; assignor to the United States of America as represented by the Secretary of the Army; Filed April 20, 1961; Serial Number 104,489; 11 Claims; (Cl. 89–14).

May 22, 1962

3,035,494; RECOIL ADJUSTING DEVICE; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Han. 26, 1960; Ser. No. 4,829; 1 Claim; (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,035,495; CARTRIDGE FEEDING MECHANISM; Eugene M. Stoner, Los Angeles, Calif.; assignor to Fairchild Engine and Airplane Corporation, Los Angeles, Calif.; a corporation of Maruland; Filed July 3, 1958; Ser. No. 746,412; 13 Claims; (Cl. 89–33).

May 29, 1962

3,036,500; BREECH BLOCK WITH SUPPORT FLAPS MOUNTED ON HINGE PINS; Paul Seifried, Dusseldorf, Germany, assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed Dec. 3, 1950; Ser. No. 856,975; 3 Clains; (Cl. 89–190).

3,036,501; FIREARMS CONTROL DEVICE FOR AUTOMATICALLY REGULATING GAS FLOW; Rolf H. Wild, Hamden, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Aug. 3, 1959; Ser. No. 831,313; 1 Claim; (Cl. 89–193).

June 6, 1962

3,037,313; CUSHIONING ATTACHMENT FOR SAFETY DEVICES; Paul A. Gring, Jr.; Reading, Pa.; assignor to The Electric Storage Battery Company, Philadelphia, Pa.; Filed Dec. 15, 1958; Ser. No. 780,386; 1 Claim; (Cl. 42–74).

June 19, 1962

3,039,221; CARTRIDGE MAGAZINE WITH ELLIPTICAL SPRINGS; Daniel D. Musgrave, 8201 Caraway St.; Cabin John, Md.; Filed Mar. 6, 1961; Ser. No. 93,745; 3 Claims; (Cl. 42–50).

3,039,222; **GUN STOCK WITH A COMPRESSIBLE FLUID RECOIL ABSORBER**; Ralph O. Hoge, 1352 N. Alta Vista, Hollywood, Calif.; Filed June 4, 1959; Ser. No. 818,199; 5 Claims; (Cl. 42–74).

3,039,364; **BARREL-FEED MECHANISM**; Irwin R. Barr; Baltimore County, Md.; assignor to Aircraft Armaments, Inc.; Cockeysville, Md.; a corporation of Maryland; Filed May 3, 1960; Ser. No. 26,568; 5 Claims; (Cl. 89–33).

3,039,365; **TIME DELAY MECHANISM FOR MACHINE GUN**;David Sylvester and Patrick E. Sweeney, Baltimore County, Md.; assignors to Aircraft Armaments, Inc.; Cockeysville, Md.; a corporation of Maryland; Filed Mar 11, 1960; Ser. No. 14,376; 3 Claims; (Cl. 89–130).

3,039,366; **TARGET PISTOL WITH BREECH BOLT LOCKING MECHANISM**; Elmer R. Imthurn, c/o Cascade Cartridge, and Kenneth W. Wyatt, 718 16th St.; both of Lewiston, Idaho; Filed Dec. 14, 1959; Ser. No. 859,364; 2 Claims; (Cl. 89–138).

June 26, 1962

3,040,628; **GUN-CATAPULT MECHANISM**; Frank W. Sieve, Falls Church, Va.; Peter Joseph Olenick, Jr.; Washington, D.C.; and David Cleonis Fowler, Silver Spring, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Continuation of application Ser. No. 574,938; Mar. 29, 1956; This application May 29, 1956; Ser. No. 588,199; 7 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

July 3, 1962

3,041,768; **FIREARM WITH TRIGGER ASSEMBLY AND SLIDE ARM ASSEMBLY SUPPORTED BY BARREL LUG**; Julius E. Brooks, Jr.; Branfort, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Sept. 1, 1960, Ser. No. 53,405; 5 Claims; (Cl. 42–16).

3,041,938; **GUN REST WITH MAGNETIC HOLDING MEANS**; John T. Seabrook, 5401 Park Road, Falls Church, Va.; Filed July 19, 1960; Ser. No. 43,809; 7 Claims; (Cl. 89–37).

3,041,939; **MULTI-BARREL GUN WITH A PLURALITY OF FIRING STATIONS AND AN AMMUNITION DRUM**; David Dardick, New York, N.Y.; assignor to Dardick Corporation; a corporation of Delaware; Filed Oct. 6, 1959; Ser. No. 844,773; 15 Claims; (Cl. 89–126).

July 10, 1962

3,043,198; **SADDLE TYPE MAGAZINE FEED**; Burns Darsie, Rockford, Ill.; and Marvin Heifetz, Milwaukee, Wis.; assignors by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed May 3, 1960; Ser. No. 26,663; 4 Claims; (Cl. 89–33).

July 17, 1962

3,044,203; **FIREARM WITH RECIPROCABLE BOLT HAVING TRANSVERSE MOVEMENT**: Gary Wilhelm, Hamden, Conn. (Apt. 54, 470 Prospect St., New Haven, Conn.); and Henry Schorn, R.F.D. 1, Sandy Hook, Conn.; Filed Aug 6, 1958; Ser. No. 753,562; 9 Claims; (Cl. 42–22).

3,044,204; **WARNING SIGNAL LIGHT FOR FIREARMS**; Clarence Robert Zimmerman, Box 6, Almira, Wash.; Filed Aug, 5, 1960; Ser. No. 47,783; 2 Claims; (Cl. 42–84).

3,044,360; **FLARE GUN**; Russell O. Stefan, 10950 Vulcan St.; Downey, Calif., and Anton G. Land, 5219 Lunsford Drive, Los Angeles, Calif.; Filed Dec. 1, 1960; Ser. No. 72,901; 1 Claim; (Cl. 89–1).

3,044,361; **CHARGER FOR FIREARMS**; Albert J. Lizza, Williamansett, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 10, 1959; Ser. No. 852,153; 8 Claims; (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,044,363; **PROPULSION MEANS FOR PROJECTILES**; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Apr. 28, 1960; Ser. No. 25,491; 2 Claims; (Cl. 89–8). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,044,364; **SAFETY INTERLOCK FOR THE FIRING MECHANISM OF A CANNON**; Herman J. Reepmeyer; Cohosa, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed Sept. 21, 1960; Ser. No. 57,589; 5 Claims; (Cl. 89–27). (Granted under Title 35, U.S. Code (1952), sec. 266).

July 24, 1962

3,045,378; **SHOTGUN CHOKE**; Louis M. Denaux, Cosgrove Ave.; O.O. Box 3258, Charleston, S.C.; Filed July 27, 1960; Ser. No. 45,687; 4 Claims; (Cl. 42–79).

3,045,379; **CHOKE ATTACHMENT FOR SHOTGUNS**; Richard M. Cutts, The Plains, Va.; Filed May 25, 1959; Ser. No. 815,662; 2 Claims; (Cl. 42–79).

3,045,553; MAGAZINE CONTAINER FOR AUTOMATIC FIREARMS; Ernst Mosle, Zurich, Switzerland; assignor to Machine Tool Works Oerlikon; Administration Company; Zurich-Oerlikon, Switzerland; a company of Switzerland; Filed Feb. 11, 1960; Ser. No. 8,075; Claims priority application Switzerland Feb. 13, 1959; 12 Claims; (Cl. 89–33).

3,045,554; ORDNANCE MOUNT AND SUPPORTING STRUCTURE THEREFOR; Ernest F. Campbell, Springfield, Va.; assignor to the United States of America as represented by the Secretary of the Navy; Filed Apr. 26, 1956; Ser. No. 580,969; 4 Claims; (Cl. 89–37). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,045,555; AUTOMATIC TRIGGER MECHANISM WITH THREE SEARS AND A ROTATABLE CONTROL MEMBER; Eugene M. Stoner, Newport Beach, Calif.; assignor to Fairchild Engine and Airplane Corporation, Hagerstown, Md.; a corporation of Maryland; Filed Dec. 22, 1959; Ser. No. 861,288; 10 Claims; (Cl. 89–142).

3,045,556; GAS OPERATED AUTOMATIC REVOLVER; Edward I. Westmoreland, 30 Newfield St.; Plymouth, Mass.; Filed Oct. 7, 1959; Ser. No. 844,989; 8 Claims; (Cl. 89–191).

July 31, 1962

3,046,842; REVOLVER GUN WITH MEANS FOR CUTTING THE LINKS OF BELTED AMMUNITION; Dimitry B. Sergay, Clawson, Mich.; assignor to General Motors Corporation, Detroit, Mich.; a corporation of Delaware; Filed June 26, 1959; Ser. No. 823,244; 4 Claims; (Cl. 89–33).

3,046,843; MORTAR BASE PLATE; Robert S. Rowe, Box Cm, Duke Station, Durham, N.C.; Filed July 15, 1960; Ser. No. 43,252; 1 Claim; (Cl. 89–37). (Granted under Title 35, U.S. Code (1952), sec. 266).

August 7, 1962

3,048,085; FLARE CANDLE; Paul J. Dickey, Sunland, Calif.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Navy; Filed Apr. 23, 1956; Ser. No. 580,148; 1 Claim; (Cl. 89–1).

August 14, 1962

3,049,056; WEAPON CONTROL SYSTEM; Paul I. Evans, Livermore, and Maurice R. Ranson, Torrance, Calif.; assignors to the United States of America as represented by the Secretary of the Army; Filed June 9, 1960; Ser. No. 35,099; 5 Claims; (Cl. 89–1).

3,049,057; CARTRIDGE BELT DELINKER AND EJECTOR; William W. Brothers, Jr.; Eglin Air Force Base, Fla.; assignor to the United States of America as represented by the Secretary of the Air Force; Filed Feb. 2, 1960; Ser. No. 6,331; 8 Claims; (Cl. 89–33). (Granted under Title 35 U.S. Code (1952), sec. 266).

August 21, 1962

3,049,977; AUTOMATIC ACTION REVOLVER; Robert J. Reich, 2135 E. Vine Ave., West Covina, Calif.; Filed June 13, 1960; Ser. No. 35,802; 15 Claims; (Cl. 89–154).

August 28, 1962

3,050,892; AUTOMATIC FIREARM UTILIZING A SPRING FOR RELOADING; Heinrich Vogler, Eggstrasse 32, Oberengstringen, near Zurich, Switzerland, and Heinz Krausser, Orleanstrasse 31, Munich, Germany; Filed Mar. 18, 1959; Ser. No. 800,148; Claims priority, application Germany Mar 21, 1958; 5 Claims; (Cl. 42–5).

3,050,894; ROTATABLY ADJUSTABLE FIRING PIN FOR CENTER OR RIM FIRE CARTRIDGES; Jessie T. Ivy, 523 Henderson St., Seattle, Wash.; Filed Mar 18, 1960; Ser. No. 15,922; 3 Claims; (Cl. 42–69).

3,051,056; AUTOMATIC GUN BREECH BLOCK CONTROL MECHANISM; Arend Willen Kuijvenhoven, Barrowby, Grantham, and Roy Gilbert Vickers, Granthan, England; assignors to Brevets Aero-Mecaniques, S.A.; Geneva, Switzerland; a body corporate of Switzerland; Filed June 10, 1959; Ser. No. 819,385; Claims priority, application Great Britain June 23, 1958; 7 Claims; (Cl. 89–132).

3,051,057; AUTOMATIC HAMMER COCKING AND CYLINDER INDEXING MEANS FOR REVOLVERS; Jessie T. Ivy, 523 Henderson St.; Seattle, Wash.; Filed Aug. 18, 1960; Ser. No. 50.507; 5 Claims; (Cl. 89–191).

3,052,053; TWIST-OPEN FIREARM; Edwin S. Vartanian, North Haven, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Mar. 1, 1961; Ser. No. 92,531; 4 Claims; (Cl. 42–13).

September 11, 1962

3,053,002; BREECH BOLT LOCK; Walter H.B. Smith, deceased, late of New York, N.Y.; by Katherine B. Groves, executrix, 150 W. 58th St.; New York, N.Y.; Filed Dec. 2, 1959; Ser. No. 856,752; 23 Claims; (Cl. 42–16).

September 18, 1962

3,054,206; MEANS FOR RETAINING MAGAZINE-FED FIREARM CARTRIDGES IN BOLT PICKUP POSITION; Edmond J. Raleigh, West Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Jan. 13, 1961; Ser. No. 82,660; 4 Claims; (Cl. 42–18). (Granted under Title 35, U.S. Code (1952), sec. 255).

3,054,207; REVOLVER WITH MOUNTING MEANS FOR THE BEARING PIN OF THE CYLINDER; Gunter Horst Rohm, Muhlstrasse 9, Southeim (Brenz), Germany; Filed May 20, 1960; Ser. No. 30,649; Claims priority, application Germany May 27, 1959; 4 Claims; (Cl. 42–62).

3,054,208; FIRING MECHANISM FOR A SPOTTING RIFLE; Charles F. Packard, East Longmeadow, and Stanley D. Silsby, Granby, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed Jan. 13, 1961; Ser. No. 82,659; 7 Claims. (Cl. 42–70). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,054,329; MISSILE LAUNCHER AND HIGH VELOCITY GUN; Frank J. Willig, Washington, D.C.; assignor to the United States of America as represented by the Secretary of the Air Force; Filed Feb. 19, 1960; Ser. No. 10,007; 6 Claims; (Cl. 89–1), (Granted under Title 35, U.S. Code (1952), sec. 266).

September 26, 1962

3,055,268; DISCARDING OBTURATOR AND ROTATOR FOR PROJECTILES; Henry Rosenthal, 1210 12th St. NW.; Washington 5, D.C.; Filed Dec. 8, 1960; Ser. No. 74,737; 2 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,055,270; AUTOMATIC REVOLVER WITH RECOILING CYLINDER FRAME; Paul C. Miller, 34 Clifton St., Worchester, Mass.; Filed Aug. 2, 1960; Ser. No. 47,108; 9 Claims. (Cl. 89–157).

October 2, 1962

3,056,225; SEAL MEANS FOR MOVABLE CHAMBER FIREARMS; Arthur S. Yeomans, Jr.; Northford, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed May 23, 1960; Ser. No. 30,808; 2 Claims; (Cl. 42–39.5).

3,056,226; FIRING PIN OF LIGHT WEIGHT MATERIAL, SUCH AS ALUMINUM OR TITANIUM; Charles L. Hubbard, Roxana, and Robert D. Smith, Marion, Ill.; assignors to the Olin Mathieson Chemical Corporation, East Alton, Ill.; a corporation of Virginia; Filed Aug. 20, 1959; Ser. No. 834,982; 6 Claims; (Cl. 42–69).

3,056,336; HIGH VELOCITY ACCELERATOR FOR PROJECTILES; Peter L. Tailer, 323 E. 17th St., New York 3, N.Y.; Filed Nov. 3, 1959; Ser. No. 850,566; 3 Claims; (Cl. 89–8).

October 9, 1962

3,057,100; EXTRACTOR FOR AUTOMATIC GUNS; Paul H. Dixon, Rockford, Ill.; assignor to United Shoe Machinery Corporation, Flemington, N.J.; a corporation of New Jersey; Filed Jan. 9, 1947; Ser. No. 721,058; 11 Claims, (Cl. 42–25).

3,057,101; ELECTIVE TRIGGER MECHANISM; Howard L. Miller and Irvin K. Miller, both of R.D. 1, Millersburg, Pa.; Filed July 6, 1960; Ser. No. 41,177; 5 Claims; (Cl. 42–42).

3,057,103; REVOLVER LOADER; Norman A. Bivens, 7700 Camillia Ave., North Hollywood, Calif.; Filed Dec. 9, 1960; Ser. No. 74,881; 4 Claims; (Cl. 42–89).

3,057,263; MEANS FOR ABSORBING ENERGY OF IMPULSE; Hugh D. MacDonald, Jr.; Philadelphia, and Robert W. Markgraf, Roslyn, Pa.; and Norman J. Waeker, Masonville, N.J.; assignors to the United States of America as represented by the Secretary of the Army; Filed Apr. 13, 1959; Ser. No. 806,196; 1 Claim; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

October 16, 1962

3,058,397; DEVICE FOR CONTROLLING A FIRING PIN; Blair B. Fowler, Monrovia, Calif.; and David A. Young, Washington, D.C., assignors to Aerojet-General Corporation, Azusa, Calif.; a corporation of Ohio; Filed Jan. 12, 1959; Ser. No. 786,346; 4 Claims; (Cl. 89–27).

3,058,398; AUTOMATIC MACHINE GUN WITH RECOILING BARREL AND HYDRAULIC ACCELERATOR; Irwin R. Barr, Baltimore County, Md.; assignor to Aircraft Armaments, Inc.; Baltimore, Md.; a corporation of Ohio; Substituted for abandoned application Ser. No. 354,975; May 14, 1953; This application Dec. 23, 1959; Ser. No. 861,714; 8 Claims; (Cl. 89–169).

3,058,399; RECEIVER WITH T-SLOT OPENING FOR A SLIDE BLOCK; Harold D. Allyn, 10 Sumner Ave.; Springfield, Mass.; Filed Dec. 14, 1959; Ser. No. 859,431; 5 Claims; (Cl. 89–191).

3,058,400; COMPENSATING DEVICE FOR GAS OPERATED FIREARMS; Ellis W. Hallston, Ilion, and Robert L. Kelly, Cooperstown, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware, Filed Jan. 23, 1959; Ser. No. 788,540; 2 Claims; (Cl. 89–193).

October 23, 1962

3,059,367; **COMPENSATING MEANS IN A BARREL CHAMBER FOR LOW AND HIGH POWERED CARTRIDGES;** Waldo E. Rosebush, Appleton, Wis.; F. Ward Rosebush and Judson G. Rosebush, Jr.; executors of said Waldo E. Rosebush, Jr.; deceased; Filed Feb. 23, 1961; Ser. No. 90,985; 2 Claims; (Cl. 42–76).

October 30, 1962

3,060,612; **MEANS FOR IMPOSING A PREDETERMINED FORCE BETWEEN ADJACENT MEMBERS;** Edwards Brown, 3433 N. 47th Way, and William S. Woodward, 6742 N. 48th St., both of Phoenix, Ariz.; and Frederick D. Wade, 7014 E. Cypress, Scottsdale, Ariz.; Filed Oct. 13, 1958; Ser. No. 767,033; 11 Claims; (Cl. 42–75).

3,060,809; **AUTOMATIC HIGH-SPEED FIREARM;** Ernst Tschumi, Schonenberg, Thurgau, Switzerland; Filed Nov. 16, 1959; Ser. No. 853,371; Claims priority, application Switzerland Dec. 2, 1958; 4 Claims; (Cl. 89–33).

3,060,810; **SEAR MECHANISM DISCONNECTED BY BREECH BLOCK MOTION;** Robert L. Hillberg, West Cheshire, Conn.; assignor, by mesne assignments to Charles E. Lowe, Sr.; Wethersfield, Conn.; Original application July 1, 1954; Ser. No. 440,601; Divided and this application June 22, 1959; Ser. No. 822,116; 5 Claims; (Cl. 89–145).

November 6, 1962

3,061,965; **SLING SWIVEL FOR GUNS;** Karl R. Lewis, Ogden, Utah, assignor to Browning Industries, Inc.; Ogden, Utah, Filed Jan. 10, 1962; Ser. No. 166,456; 5 Claims; (Cl. 42–85).

November 13, 1962

3,063,184; **FIREARM MUZZLE COVER;** Justin G. Sukala, 1731 Melrose Ave.; Natrona Heights, Pa.; Filed Mar. 2, 1960; Ser. No. 12,370; 3 Claims; (Cl. 42–1).

November 20, 1962

3,064,381; **COMBINATION FIREARM AND GRENADE;** Jean Vilbajo, Burcht, Belgium, assignor to A.V.R.; Achat, Ventes, Representations, Society Anonyme, Brussels, Belgium; Filed Feb. 23, 1960; Ser. No. 10,443; Claims priority, application Belgium Oct. 28, 1959; 4 Claims; (Cl. 42–1).

3,064,382; **GUN WITH EJECTION THROUGH HAND GRIP;** John L. Hill, 3316 Norfolk, Apt. D., Houston 6, Tex.; Original application Dec. 19, 1956; Ser. No. 629,354; now Patent No. 2,882,635; dated Apr. 21, 1959; Divided and this application Sept. 12, 1958; Ser. No. 760,710; 2 Claims; (Cl. 42–25).

3,064,383; **SAFETY TRIGGER LOCK FOR FIREARMS;** Clarence W. Newson, Sr.; 854 W. 3rd N.; Salt Lake City, Utah; Filed Jan. 27, 1961; Ser. No. 85,307; 8 Claims; (Cl. 42–70).

3,064,539; **SEALING ARRANGEMENT FOR A PIVOTED CLOSURE;** Richard T. Cowley, Ellicott City, Md.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Navy; Filed May 22, 1959; Ser. No. 815,238; 3 Claims; (Cl. 89–37.5).

November 27, 1962

3,065,560; **FIRING MECHANISM FOR GUNS;** Jacques Bumiller, Valence, France; assignor by mesne assignments to Sarmi, S.A., Societe d'Applications de Recherches Minieves et Industrielles, Lenzerhelde, Switzerland; Original application Nov. 21, 1958; Ser. No. 775,484; Divided and this application Feb. 29, 1960; Ser. No. 11,628; Claims priority, application France Dec. 4, 1957; 4 Claims; (Cl. 42–68).

December 4, 1962

3,066,433; **TRIGGER LOCK FITTING ON A TRIGGER GUARD;** Eugene E. Rogers and Edward R. Maskulka, Phoenix, Ariz.; assignors of twenty percent to Carl S. Spaw, Phoenix, Arix.; Filed Feb. 24, 1960; Ser. No. 10,740; 2 Claims; (Cl. 42–70).

December 18, 1962

4,068,755; **APPARATUS FOR AND METHOD OF VARYING INITIAL VELOCITY OF HEDGEHOG PROJECTOR CHARGES;** Charles A. Johnstone, Arlington, Va.; Sidney Hersch, Silver Spring, Md.; Marvin H. Meekins, Falls Church, Ba.; and Larry Shiller, Silver Spring, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed Aug. 1, 1952; Ser. No. 302,284; 4 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,068,756; **DISCHARGERS FOR PYROTECHNIC DEVICES**; Alfred James Schermuly, Newdigate, Dorking, England, assignor to The Schermuly Pistol Rocket Apparatus Limited, Newdigate, Dorking, England, a company of Great Britain; Filed Dec. 2, 1959; Ser. No. 856,714; Claims priority; application Great Britain Dec. 10, 1958; 3 Claims; (Cl. 89–1.5).

3,068,757; **ARMORED TANK PROVIDING PRESSURIZED CIRCULATION OF VENTILATING AIR**; Georges Even, 3 Blvd. Victor, Paris 15, France; Filed Mar. 18, 1958; Ser. No. 722,192; Claims priority; application France Mar. 21, 1957; 5 Claims, (Cl. 89–36).

3,069,976; **GAS-OPERATED SEMIAUTOMATIC PISTOL**; Frederick F. Stevens, Jr.; Brooklyn, N.Y.; (Lanes Pond Road, Northford, Conn.); Filed Dec. 6, 1957; Ser. No. 701,035; 12 Claims; (Cl. 89–191).

January 1, 1963

3,071,043; **RECOIL-OPERATED MULTIPLE BARREL GUN**; William D. McThomas, Arlington Heights, Ill., assignor, as represented by the Secretary of the Army; Filed September 17, 1957; Serial No. 684,623; 1 Claim. (Cl. 89–12).

3,071,044; **BREECH BLOCK**; John Kapitula, 143 Van Horne St., Jersey City, N. J.; Filed September 13, 1957; Serial No. 683,801; 1 Claim. (Cl. 89–17).

January 22, 1963

3,074,322; **BREECH MECHANISM FOR AN ARTILLERY DEVICE OF THE MUZZLE-LOADING TYPE**; Joseph Raymond Jasse, Paris, France, assignor to Hotchkiss-Brandt, Paris, France, a French body corporate; Filed May 2, 1961; Serial No. 120,813; Claims priority, application France May 10, 1960; 6 Claims. (Cl. 89–27).

January 29, 1963

3,075,312; **SET TRIGGER MECHANISM**; Merle H. Walker, Ilion, N. Y., assignor to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Filed February 3, 1960; Serial No. 6,505; 6 Claims. (Cl. 42–69).

3,075,313; **BREECH BOLT FIREARM WITH MOVABLE FOREARM AND ACTION BARS**; Harold D. Allyn, 10 Summer Avenue, Springfield, Mass.; Continuation of Application Serial No. 566,267, February 17, 1956, now Patent No. 2,922,240, dated January 26, 1960; This application January 25, 1960; Serial No. 4,292; 6 Claims. (Cl. 42–71).

3,075,314; **HAND GUARD FOR RIFLES**; Marinus A. Bakker, Hilversum, Netherlands, assignor to Staatsbedrijf Artillerie-Inrichtingen, Hemburg-Zaandam, Netherlands, a corporation of the Netherlands; Filed August 26, 1960; Serial No. 52,299; Claims priority, application Netherlands September 9, 1959; 2 Claims. (Cl. 42–71).

3,075,433; **ELECTRIC MACHINE GUN**; Charles A. Stockholm, Route 1, P. O. Box 948, Beaumont, Texas; Filed October 11, 1960; Serial No. 62,034; 9 Claims. (Cl. 89–13).

3,075,434; **AMMUNITION TRANSFER MECHANISM**; Carl V. Hickman, deceased, late of Washington, D.C., by Jean W. Hickman, administratrix, Washington, D.C., and Richard E. Taylor, Washington, D.C., and Robert Butterworth, District Heights, Herman G. Miller, Mayo, Alvah E. Young, Detour, and William M. Powell, Forest Heights, Md., assignors to the United States of America as represented by the Secretary of the Navy; Filed August 17, 1952; Serial No. 306,744; 66 Claims. (Cl. 89–45); (Granted under Title 35, U.S. Code (1952), sec. 266).

February 5, 1963

3,076,280; **MEANS FOR REMOVABLY SECURING A BAYONET TO A RIFLE**; Johannes Bervoets, Zaandam, Netherlands; assignor to Staatsbedrijf Artillerie-Inrichtingen, Hembrug-Zaandam, Netherlands, a corporation of the Netherlands; Filed March 30, 1961, Serial No. 99,615; 3 Claims. (Cl. 42–86).

3,076,386; **DEVICE FOR SUPPLYING AMMUNITION TO AN AUTOMATIC FIREARM**; Hermann Wey, Wallisellen, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikon, Switzerland; Filed June 2, 1961; Serial No. 114,372; Claims priority, application Switzerland June 2, 1960; 4 Claims. (Cl. 89–33).

February 12, 1963

3,077,044; **COMBINED CARTRIDGE EJECTOR AND RETAINER**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed November 2, 1960, Serial No. 66,891; 8 Claims. (Cl. 42–25); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,077,045; **SHOTGUN ACTION**; Walter H. B. Smith, deceased, late of New York, N. Y., by Katherine B. Groves, executrix, 150 W. 58th Street, New York, N. Y.; Filed December 2, 1959; Serial No. 856,751; 1 Claim. (Cl. 42–41).

February 26, 1963

3,078,765; **CARTRIDGE BELT LINK WITH REMOVABLE LOOP CLOSING COVER**; James F. Falcone and Alexander Hammer, Springfield, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed October 11, 1960; Serial No. 62,059; 5 Claims. (Cl. 89–35); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,078,766; **EQUILIBRATOR FOR A GUN**; Wright K. Gannett and Harold H. Wiese, Davenport, Iowa, assignors to the United States of America as represented by the Secretary of the Army; Filed June 8, 1960, Serial No. 34,853; 4 Claims. (Cl. 89–37).

March 5, 1963

3,079,718; **FIRING MECHANISM WITH VARIABLE CONTACT SEAR NOTCH**; Harold D. Allyn, 10 Sumner Ave., Springfield, Mass.; Filed May 19, 1959; Serial No. 814,219; 1 Claim. (Cl. 42–69).

March 12, 1963

3,080,793; POSITIVE CARTRIDGE INDEXING DEVICE; Alfred L. Montana, East Longmeadow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed December 24, 1960; Serial No. 75,891; 1 Claim. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

March 26, 1963

3,082,667; AUTOMATIC GUNS HAVING A FIXED FEED MECHANISM AND SLIDABLE IN A CRADLE; Robert Ramseyer, Versoix-Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed March 12, 1959; Serial No. 799,035; Claims priority, application Luxembourg March 25, 1958; 8 Claims. (Cl. 89–40).

April 9, 1963

3,084,466; WEAPON OF SELF-DEFENSE; Joseph Gray Duncan III, 31 Revere Road, Drexel Hill, Pa.; Filed Dec. 13, 1961; Serial No. 159,192; 2 Claims. (Cl. 42–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,084,597; EXPLOSIVE QUICK-DISCONNECT; Raymond H. Beyer, Fort Worth, Texas, assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed January 11, 1961; Serial No. 82,142; 2 Claims. (Cl. 89–1).

3,084,601; IGNITION SYSTEM FOR PROPELLANTS; William F. Kaufmann, Jr., and Henry S. Lipinski, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Filed March 17, 1961; Serial No. 96,618; 4 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

April 16, 1963

3,085,360; SAFETY DEVICE FOR REVOLVERS; Lewis C. Robbins, Washington, D.C., and Leslie Gordon Smith, Bannethoot, Viet-Nam; said Smith assignor to said Robbins; Original application November 26, 1958; Serial No. 776,480, now Patent No. 2,997,801, dated August 29, 1961; Divided and this application March 8, 1961; Serial No. 105,839; 1 Claim (Cl. 42–66).

April 23, 1963

3,086,310; SAFETY FOR DOUBLE ACTION TRIGGER MECHANISM; David L. Katz, Longmeadow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed December 14, 1960; Serial No. 75,888; 2 Claims. (Cl. 42–70); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,086,424; MASS ACCELERATOR; Tseng W. Liao, Pittsfield, Mass.; assignor to General Electric Company; a corporation of New York; Filed July 18, 1956; Serial Number 598,678; 4 Claims. (Cl. 89–8).

3,086,425; TURRET AND ELECTRONIC SIGHTING STATION; Homer D. Hucy, Baltimore, Md., assignor to Martin-Marietta Corporation, a corporation of Maryland; Filed May 29, 1946; Serial No. 673,198; 12 Claims. (Cl. 89–37.5).

April 30, 1963

3,087,270; AMMUNITION MAGAZINE WITH A COIL SPRING; Eugene M. Stoner, Newport Beach, California, assignor to Fairchild Engine and Airplane Corporation, Hagerstown, Mc., a corporation of Maryland; Filed March 21, 1960; Serial No. 16,342; 6 Claims. (Cl. 42–50)

3,087,385; TIME DELAY ACTUATING MECHANISM; Oswald Suter, Los Angeles, California, assignor to Technical Oil Tool Corporation, Los Angeles, California, a corporation of California; Filed August 12, 1960; Serial No. 69,534; 9 Claims. (Cl. 89–1).

3,087,387; SHELL CATCHER FOR FIREARMS; Val A. Browning, Ogden, Utah, assignor to Browning Industries, Inc., Ogden, Utah, a corporation of Utah; Filed February 14, 1961; Serial No. 89,316; 12 Claims. (Cl. 89–33).

May 7, 1963

3,088,376; RING FOR IMPARTING SPIN; Robert L. Davis, Hyattsville, Md., assignor to the United States of America as represented by the Secretary of the Navy; Filed March 26, 1961; Serial No. 182,695; 1 Claim. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,088,378; PISTOL WITH SLIDABLE AND FIXED BREECH BLOCK; John L. Boudreau, 655 Short Beach Road, Stratford, Conn.; Filed July 5, 1960; Serial No. 40,582; 10 Claims. (Cl. 89–161).

May 14, 1963

3,089,272; LOCKING TYPE SAFETY BREECH PLUG FOR FIREARMS; Don E. McKinlay, 511 Palmer Avenue, Lincoln, Ill.; Filed July 31, 1961; Serial No. 128,935; 9 Claims (Cl. 42–1).

3,089,273; **LOCKING DEVICE FOR CHOKES FOR SHOTGUNS**; Maurice Philippe, 39 Rue Hoche, Courbevoie (Seine), France; Filed April 24, 1961; Serial No. 104,908; Claims priority, application France; May 12, 1960; 5 Claims. (Cl. 42–79).

3,089,391; **COMBINATION ACTUATOR AND DETENT DEVICE FOR GUNS**; Edmond J. Raleigh, West Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed September 22, 1961; Serial No. 140,143; 7 Claims. (Cl. 89–198); (Granted under Title 35, U.S. Code (1952), sec. 266).

May 21, 1963

3,090,148; **BOLT ACTION FIREARM WITH CHARGER**; Walter H. B. Smith, Van Dorn Hotel, 150 W. 58th Street, New York, N. Y.; Original application April 5, 1956; Serial No. 576,275, now Patent No. 2,894,346, dated July 14, 1959; Divided and this application October 15, 1958; Serial No. 767,358; 1 Claim. (Cl. 42–25).

3,090,149; **FIREARM EXTRACTOR**; Remy Michel Pierre Marlas, Paris, France (c/o Adjudant Marlas, Armurerie de garnison d'Orange, Orange, Vaucluse, France); Filed July 1, 1960; Serial No. 40,405; Claims priority, application France July 3, 1959; 1 Claim. (Cl. 42–25).

3,090,150; **HAND GUARD CONSTRUCTION**; Eugene M. Stoner, Newport Beach, California, assignor to Fairchild Engine and Airplane Corporation, Hagerstown, Md., a corporation of Maryland; Filed June 13, 1960; Serial No. 35,617; 9 Claims. (Cl. 42–71).

June 4, 1963

3,091,878; **AUXILIARY FIREARM TRIGGER WITH INTEGRAL SAFETY**; Giulio V. Savioli, Westfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed May 24, 1962; Serial No. 197,549; 6 Claims. (Cl. 42–69); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,091,994; **GUN TURRET**; Ake T. G. Segerberg, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed November 3, 1959; Serial No. 850,604; Claims priority, application Sweden November 20, 1958; 5 Claims. (Cl. 89–36).

June 11, 1963

3,092,924; **LEVER ACTION FIREARM**; Louis W. Seecamp, 385 Orange Street, New Haven, Conn.; Filed November 22, 1961; Serial No. 154,214; 10 Claims. (Cl. 42–22).

3,093,032; **FLOATING TRACKS**; Richard C. Wilson, Champlin, Minn., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Original application October 22, 1959; Serial No. 848,163; Divided and this application January 20, 1960; Serial No. 3,700; 4 Claims. (Cl. 89–1.7).

June 18, 1963

3,093,922; **REVOLVER CYLINDER AND MOUNTING THEREFOR**; Jessie T. Ivy, 523 Henderson Street, Seattle, Washington; Filed April 24, 1961; Serial No. 105,228; 6 Claims. (Cl. 42–62).

June 25, 1963

3,094,803; **BOLT ACTION MAGAZINE FIREARM WITH A CANTILEVER SPRING FOR HOLDING CARTRIDGES IN THE MAGAZINE**; Frank T. Green, Haydenville, Mass., assignor to Noble Manufacturing Co., Inc., Haydenville, Mass., a corporation of Massachusetts; Filed February 23, 1961; Serial No. 91,072; 9 Claims. (Cl. 42–18).

July 2, 1963

3,095,781; **REPEATER-TYPE COCKING FIRING MECHANISM FOR GUNS**; Erich Bartels, Ratingen, near Dusseldorf, Germany, assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed July 25, 1961; Serial No. 127,454; Claims priority, application Germany July 29, 1960; 1 Claim. (Cl. 89–27).

July 16, 1963

3,097,564; **SPOTTING RIFLE IGNITION FOR LARGER CALIBER GUN**; Thomas-Stevenson, 1039 Arthur Avenue, Huntingdon Valley, Pa.; Filed July 21, 1961; Serial No. 125,881; 2 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

July 23, 1963

3,098,311; **BOLT STOP FOR SEMIAUTOMATIC FIREARM**; Giulio V. Savioli, Westfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed February 27, 1962; Serial No. 176,164; 6 Claims. (Cl. 42–18); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,098,410; **ADJUSTING MECHANISM FOR RECOILLESS RIFLE SPOTTING BARREL**; Edward M. Giza, Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of the Army; Filed November 26, 1962; Serial No. 240,185; 5 Claims. (Cl. 89–1.7); (Granted under Title 35, U.S. Code (1952), sec. 266).

August 6, 1963

3,099,937; **GUN WITH CARTRIDGE MAGAZINE OR PROPELLANT CHARGE MAGAZINE**; Erich Bartels, Ratingen, Germany, assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed September 26, 1960; Serial No. 58,439; Claims priority, application Germany September 26, 1959; 2 Claims. (Cl. 89–24).

3,099,938; **ARMAMENT FOR JET AIRCRAFT**; Edmund V. Marshall and Will S. Davies, Dallas, Texas, assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed April 30, 1957; Serial No. 656,170; 1 Claim. (Cl. 89–37.5).

August 13, 1963

3,100,357; **FOLDABLE BUTT FOR PORTABLE SMALL ARMS**; Paul Tellie, Saint-Etienne, France, assignor to Manufacture Nationale d'Armes de Saint-Etienne, Saint-Etienne, France, a corporation of France; Filed May 12, 1961; Serial No. 109,532; Claims priority, application France July 20, 1960; 3 Claims. (Cl. 42–72).

3,100,358; **RIFLED GUN BARREL**; Thomas R. Robinson, Jr., New Haven, Conn., assignor to The Marlin Firearms Company, New Haven, Conn., a corporation of Connecticut; Continuation of application Serial No. 354,712, May 13, 1953; This application November 27, 1959; Serial No. 856,331; 2 Claims. (Cl. 42–78).

August 20, 1963

3,101,027; **QUICK-RELEASE, LINK-TYPE CLAMP FOR MULTIPLE SHAFT CLUSTERS**; John E. Brogan, Lenox, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed August 2, 1961; Serial No. 128,906; 7 Claims. (Cl. 89–12).

3,101,028; **DEVICE FOR GUNS ON COMBAT VEHICLES**; Sven Erik Berge, Stockholm, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish company; Filed July 6, 1961; Serial No. 122,206; 2 Claims. (Cl. 89–14).

3,101,029; **FEEDING MECHANISM FOR DRUM-TYPE FIREARM**; Joseph L. Johnston, Hartland, Wis., and Anders G. Petterson, Fraser, Mich., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed November 4, 1960; Serial No. 67,445; 5 Claims. (Cl. 89–33).

August 27, 1963

3,101,647; **AMMUNITION HANDLING APPARATUS**; Chester W. Greene, Lynn, Mass., assignor to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey; Filed April 4, 1952; Serial No. 280,524; 14 Claims. (Cl. 89–46).

3,101,648; **AUTOMATIC FIREARM WITH MEANS FOR MAINTAINING SLOW RATE OF FIRING**; Fritz Walther, Wettersteinweg 4, Ulm (Danube), Germany; Filed Jan. 11, 1960; Serial No. 1,797; Claims priority, application Germany January 14, 1959; 5 Claims. (Cl. 89–183).

September 3, 1963

3,102,354; **SHOTGUN FIRING MECHANISM WITH THUMB-OPERATED COCKING PIECE**; Klas Harding Hardfalk, Anasvagen 21, Goteborg, Sweden; Filed February 14, 1961; Serial No. 89,232; 4 Claims. (Cl. 42–41).

3,102,451; **WEAPON MOUNT**; Ernest F. Campbell, Springfield, Va., assignor to the United States of America as represented by the Secretary of the Navy; Original application July 29, 1955; Serial No. 525,403; Divided and this application October 31, 1958, Serial No. 779,801; 3 Claims. (Cl. 89–41); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,102,452; **RAMMING MECHANISM FOR A GUN**; Charles J. Gross, Melrose, Mass., assignor to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey; Filed April 4, 1952; Serial No. 280,498; 16 Claims. (Cl. 89–47).

September 10, 1963

3,103,142; **BOLT MECHANISM FOR AN AUTOMATIC FIREARM**; William P. Hidden, Wenham, Mass., Lawrence E. Steimen, Topsfield, Mass., and Robert N. Sandberg, deceased, late of Beverly, Mass., by Sara F. Sandberg, administratrix, Beverly, Mass., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed January 13, 1961; Serial No. 82,661; 9 Claims. (Cl. 89–188).

September 17, 1963

3,103,757; **BOLT ACTION RIFLE WITH EJECTOR HOUSING ON MAGAZINE BOX**; Nicholas L. Brewer, deceased, late of Tarpon Springs, Fla., by Margaret W. Brewer, executrix, Tarpon Springs, Fla., assignor, by mesne assignments, to Savage Arms

Corporation, Westfield, Mass., a corporation of Delaware; Original application November 20, 1958; Serial No. 775,143, now Patent No. 3,005,279, dated October 24, 1961; Divided and this application May 12, 1961; Serial No. 126,741; 7 Claims. (Cl. 42–25).

3,103,758; **FIRING MECHANISM FOR FIREARMS**; Gary Wilhelm, Hamden, Conn., Assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed December 22, 1960; Serial No. 77,742; 7 Claims. (Cl. 42–69).

3,103,851; **CHARGER FOR A GUN**; Robert A. Rosenblum, Skokie, and Edwin W. Johnson, Mount Prospect, Ill., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed April 13, 1961; Serial No. 102,900; 5 Claims. (Cl. 89–1).

September 24, 1963

3,104,588; **AUTOMATIC WEAPON AND AMMUNITION**; James O. Glorvig, 1075 Coronet Avenue, Pasadena, California; Filed February 8, 1961; Serial No. 87,978; 2 Claims. (Cl. 89–33); (Granted under Title 35, U.S. Code (1952), sec. 266).

October 1, 1963

3,105,411; **RECOIL ABSORBING MECHANISM**; Val A. Browning, Ogden, Utah, assignor to Browning Industries, Inc., Ogden, Utah, a corporation of Utah; Filed July 24, 1961; Serial No. 126,205; 13 Claims. (Cl. 89–177).

October 8, 1963

3,106,033; **FIRING MECHANISM WITH SEAR SAFETY INDICATOR**; Nicholas L. Brewer, deceased, late of Tarpon Springs, Fla., by Margaret W. Brewer, executrix, Tarpon Springs, Fla., assignor by mesne assignments, to Savage Arms Corporation, Westfield, Mass., a corporation of Delaware; Original application November 20, 1958; Serial No. 775,143, now Patent No. 3,005,279, dated October 24, 1961; Divided and this application June 12, 1961; Serial No. 125,021; 9 Claims. (Cl. 42–69).

3,106,131; **CARTRIDGE ACTUATED DEVICE**; Irwin R. Barr, Lutherville, and Nicholas J. La Costa, Phoenix, Md., assignors to Aircraft Armaments, Inc., Cockeysville, Md., a corporation of Maryland Continuation of application; Serial No. 787,880; January 20, 1959; This application May 24, 1961; Serial No. 120,838; 5 Claims. (Cl. 89–1).

October 15, 1963

3,106,795; **PIVOTED TRIGGER-GUARD FOR FIREARMS**; George A. Wilson, Hamden, Conn., assignor to The High Standard Manufacturing Corporation, New Haven, Conn., a corporation of Connecticut; Filed July 1, 1949; Serial No. 102,473; 12 Claims. (Cl. 42–69).

3,106,865; **LOADING DEVICE FOR AUTOMATIC FIREARMS HAVING A REVOLVER DRUM**; Erwin Heperie, Dietlikon, Zurich-Eichelacker, Switzerland, assignor to Machine Tool Works Oerlikon Administration Company, Zurich-Oerlikon, Switzerland; Filed June 16, 1960; Serial No. 36,518; Claims priority, application Switzerland June 18, 1959; 2 Claims. (Cl. 89–33).

3,106,866; **GUN LOADING MECHANISM**; Hans Klapdohr, Erkrath, near Dusseldorf, Heinrich Binder, Neuss, and Franz Horn and Otto Peus, Dusseldorf, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed July 13, 1960; Serial No. 42,604; Claims priority, application Germany July 15, 1959; 11 Claims. (Cl. 89–45).

October 22, 1963

3,107,450; **GLASS FIBER SIGHT RIB FOR FIREARM BARRELS HAVING AN OUTER JACKET OF GLASS FIBERS**; George R. Snyder, Woodbridge, and Joseph W. Silva, New Haven, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed May 19, 1961; Serial No. 111,195; 13 Claims. (Cl. 42–76).

November 5, 1963

3,109,253; **DEFENSIVE WEAPON**; Saul Eig, P. O. Box 611, Biscayne Annex, Miami, Fla.; Filed November 5, 1962; Serial No. 235,440; 6 Claims. (Cl. 42–1).

November 5, 1963

3,109,344; **LOADING RACK FOR AMMUNITION CARTRIDGES**; Gustav Tore Andersson, Karlskoga, and Gustaf Olof Engman, Bofors, Sweden, assignors to Aktiebolaget Bofors, Bofors, Sweden, a Sweedish company; Filed December 29, 1960; Serial No. 79,263; Claims priority, application Sweden January 5, 1960; 6 Claims. (Cl. 89–34).

3,109,345; FIREARM WITH DISCONNECTOR OPERATED BY BREECH BOLT LOCK, AND OTHER IMPROVEMENTS; Joseph W. Norman, Springfield, Mass., assignor to Smith and Wesson, Inc., Springfield, Mass., a corporation of Massachusetts; Filed August 22, 1960; Serial No. 50,970; 9 Claims. (Cl. 89–144).

November 12, 1963

3,110,122; FIREARM MAGAZINE WITH TWO OPPOSITELY DISPOSED FEED ENDS; Daniel D. Musgrave, 8201 Caraway Street, Cabin John, Md.; Filed November 3, 1961; Serial No. 150,043; 4 Claims. (Cl. 42–50).

3,110,220; EJECTOR MECHANISM FOR ARTILLERY GUNS; Walter H. Austin, Jr., Poestenkill, and Willard F. Frey, Selkirk, N. Y., assignors to the United States of America as represented by the Secretary of the Army; Filed February 21, 1963; Serial No. 260,965; 6 Claims. (Cl. 89–21); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,110,221; MACHINE GUN SELECTIVELY OPERATED BY A GAS OR RECOIL SYSTEM; John L. Lochhead, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed April 5, 1962; Serial No. 185,485; 8 Claims. (Cl. 89–159); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,110,222; GAS ASSIST SYSTEM FOR RECOIL ACTUATED FIREARMS;Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed April 5, 1962; Serial No. 185,486; 2 Claims. (Cl. 89-159); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,110,223; RECONDITIONED FIREARMS; Stuart A. Schlappich, 648 N. 10th Street, Reading, Pa.; Filed July 21, 1960; Serial No. 44,392; 1 Claim. (Cl. 89–196).

November 19, 1963

3,111,061; OPERATING MECHANISM FOR GUN BREECHES;Paul Zehfeld, Dusseldorf, and Herbert Grossechopf, Grevenbroich, Lower Rhine, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed January 30, 1962; Serial No. 169,780; Claims priority, application Germany February 6, 1961; 6 Claims. (Cl. 89–24).

November 26, 1963

3,111,882; MUZZLE VELOCITY COMPENSATING DEVICE; C. Walton Musser, Beverly, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 5, 1961; Serial No. 122,043; 3 Claims; (Cl. 89–14). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,111,883; RECOILING BARREL-RECEIVER ASSEMBLY; Richard L. Brown, Branford, and George Dmitrieff, Bethany, Conn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed June 13, 1962; Serial No. 202,264; 5 Claims. (Cl. 89–165).

December 3, 1963

3,112,670; GAS PRESSURE OPERATED DEVICE; Charles J. Kitz, Jr., Philadelphia, Pa., assignor to the United States of America as represented by the Secretary of the Army; Filed September 26, 1962; Serial No. 227,634; 1 Claim. (Cl. 89–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,112,673; THREE-PIECE DISINTEGRATING AND RELINKING AMMUNITION BELT LINK; John William Sarvis, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed August 28, 1962; Serial No. 220,101; 5 Claims. (Cl. 89–35); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,112,674; MORTAR WITHOUT RECOIL BRAKE; Joseph Raymond Jasse, Paris, France, assignor to Hotchkiss-Brandt, Paris, France, a French body corporate; Filed June 27, 1961; Serial No. 119,862; Claims priority, application France June 28, 1960; 21 Claims. (Cl. 89–37).

3,112,675; LOCKING SYSTEM FOR TILTING FIREARM BOLT; Richard H. Colby, South Hadley, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed June 22, 1962; Serial No. 204,657; 3 Claims. (Cl. 89–184); (Granted under Title 35, U.S. Code (1952), sec. 266).

December 17, 1963

3,114,289; MUZZLE BRAKE; William E. Aulabaugh, P. O. Box 72, Los Molinois, California; Filed July 12, 1962; Serial No. 209,413; 1 Claim. (Cl. 89–14).

3,114,290; BREECH SEALING MEANS FOR AUTOMATIC FIREARMS ADAPTED TO FIRE CASELESS AMMUNITION; Earle M. Harvey, Agawam, and Frederick P. Reed, Ludlow, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed October 12, 1962; Serial No. 230,297; 16 Claims. (Cl. 89–26); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,114,291; **RECOIL MECHANISM**; Eugene Ashley, Burlington, Vt., assignor to General Electric Company, a corporation of New York; Filed December 30, 1960; Serial No. 79,634; 7 Claims. (Cl. 89–42).

December 24, 1963

3,115,060; **GAS INERTIA CONTROLLER**; Clifford L. Ashbrook, 5027 Cheena Street, and Wilson G. Wing, 33 E. Rivercrest, both of Houston, Texas; Filed June 20, 1961; Serial No. 118,440; 7 Claims. (Cl. 89–14).

3,115,061; **DISINTEGRATING AND RELINKING AMMUNITION BELT LINK**; John William Sarvis and Joseph R. Mayer, Springfield, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed July 6, 1962; Serial No. 208,147; 4 Claims. (Cl. 89–35). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,115,062; **TURRET MOUNT**; Douglas P. Tassie, St. George, and Lewis K. Wetzel, Burlington, Vt., assignors to General Electric Company, a corporation of New York; Filed April 2, 1962; Serial No. 184,087; 11 Claims. (Cl. 89–37).

3,115,063; **RECOIL ABSORBING MECHANISM FOR FIREARMS**; Val A. Browning; Ogden, Utah; assignor to Browning Industries, Inc., Ogden, Utah; a corporation of Utah; Filed June 27, 1961; Serial Number 120,057; 8 Claims. (Cl. 89–177).

January 7, 1964

3,118,242; **SUB-AQUATIC GUN**; George R. Snyder, Woodbridge, Conn.; assignor to Olin Mathieson Chemical Corporation, New Haven, Conn.; a corporation of Virginia; Filed Nov. 6, 1961; Ser. No. 150,581; 3 Claims; (Cl. 42–1).

3,118,243; **RIFLED BARREL FOR FIREARMS**; Jack C. Manshel, P.O. Box 186, Palmdale, Calif.; Filed May 17, 1961; Ser. No. 110,688; 1 Claim. (Cl. 42–76).

3,118,342; **BORE EVACUATOR FOR CANNONS**; Alfred A. Campione, Rotterdam, and Herman A. Tobonsky, Colonie, N.Y.; assignors to the United States of America as represented by the Secretary of the Army; Filed June 11, 1963; Ser. No. 201,741; 3 Claims; (Cl. 89–1). (Granted under ile 35, U.S. Cdoe (1952), sec. 266).

January 28, 1964

3,119,302; **GAS SEALED EXPLOSIVE PROPELLING ARRANGEMENT**; Irwin R. Barr, Lutherville, Md.; assignor to Aircraft Armaments, Inc.; Cockeysville, Md.; a corporation of Maryland; Filed June 5, 1961; Ser. No. 114,891; 6 Claims; (Cl. 89–1).

3,119,303; **GYRATORY SELF-PROPELLED PROJECTILE**; Joseph Raymond Jasse, Paris, France; assignor to Hotchkiss-Brandt, Paris, France; a French body corporation; Filed Aug. 8, 1961; Ser. No. 130,082; Claims priority, application France Sept. 23, 1960; 4 Claims; (Cl. 89–1.7).

February 4, 1964

3,120,070; **COMBINATION BOLT HOLDING AND CARTRIDGE FEEDING DEVICE FOR A MAGAZINE-TYPE FIREARM**; Fredrick P. Reed, Ludlow, Mass.; assignor to he Unied Saes of America as represened by the Secretary of the Army; Filed Aug. 20, 1962; Ser. No. 218,184; 5 Claims; (Cl. 42–18); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,120,071; **EXTRACTOR MECHANISM FOR FIREARMS**; Henry M. Pernini, Chicago, Ill.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Feb. 5, 1963; Ser. No. 256,483; 6 Claims; (Cl. 42–25).

3,120,151; **EJECTABLE TAIL UNIT FOR THE PROPELLING LAUNCHING CHARGE OF A PROJECTILE WHICH IS LOADED THROUGH THE MUZZLE OF THE FIRING MEANS**; Joseph Raymong Jasse, Paris, France; assignor to Hotchkiss-Brandt, Paris, France, a body corporate of France; Filed June 25, 1962; Ser. No. 204,743; Claims priority, application France July 3, 1961; 4 Claims; (Cl. 89–1).

3,120,152; **AMMUNITION DRUM FOR AUTOMATIC WEAPONS**; Kurt Horn and Heinrich Paschke, Dusseldorf, Germany, assignors to Firma Rheinmetall B.m.b.H.; Dusseldorf, Germany; Filed Jan. 19, 1960; Ser. No. 3,389; Claims priority, application Germany Jan. 20, 1959; 7 Claims; (Cl. 89–33).

February 11, 1964

3,120,713; **COOPERATING BARREL LOCKING AND SAFETY DEVICE**; Albert J. Lizza, North Wilbraham, and Alfred L. Montana, East Longmeadow, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed July 10, 1962; Ser. No. 208,974; 4 Claims; (Cl. 42–70). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,120,785; **CANNON RAMMING DEVICE**; John D. Lorimer, Birmingham, John F. Schuch, St. Clair Shores, and Richard W. Kucharski, Warren, Mich.; assignors to Cadillac Gage Company, Roseville, Mich.; Filed Jan. 5, 1962; Ser. No. 164,540; 5 Claims; (Cl. 89–47).

February 25, 1964

3,122,055; **BORE EVACUATOR FOR ARTILLERY TYPE GUNS**; Donald M. Roeck, Sr.; Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 6, 1962; Ser. No. 200,590; 1 Claim; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,122,060; **COOPERATING FIRING AND INDEXING DEVICES FOR REVOLVER-TYPE FIREARMS**; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Aug. 23, 1962; Ser. No. 219,085; 7 Claims; (Cl. 89–155). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,122,061; **RECOIL SPRING GUIDE AND MUZZLE WEIGHT**; Maxwell G. Atchisson, 1845 N. Garfield, Hollywood, Calif.; Filed May 17, 1962; Ser. No. 195,449; 4 Claims; (Cl. 89–198).

March 3, 1964

3,122,967; **AMMUNITION HANDLING AND LOADING SYSTEM FOR MAJOR CALIBER GUNS**; Carl T. Johnson and Garold A. Kane, Minneapolis, Milton C. Neuman, Champlin, and Kenneth A. Riach, Minneapolis, Minn.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Navy; Filed Nov. 28, 1958; Ser. No. 777,161; 8 Claims; (Cl. 89–46).

March 10, 1964

3,123,927; **COMBINED SUPPORT AND CHAMBERING GUIDE FOR MAGAZINE-FED CARTRIDGES WITH FRAGILE PROJECTILES**; David L. Katz, Longmeadow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Dec. 27, 1962; Ser. No. 247,769; 5 Claims; (Cl. 42–18); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,123,928; **CONTRACTABLE SHOULDER ARM WITH RIFLE AND SHOTGUN UNIT**; Albert J. Lizza, 14 Linwood Drive, North Wilbraham, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Dec. 13, 1961; Ser. No. 159,191; 2 Claims; (Cl. 42–72); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,123,929; **FIREARM CHOKE MOUNTING**; Frank A. Pachmayr, Los Angeles, and Walter R. Nass, Escondido, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed Jan. 16, 1962; Ser. No. 166,534; 12 Claims; (Cl. 42–79).

March 17, 1964

3,124,889; **REVOLVER GATE**; Douglas R. Hellstrom, Wellesley Hills, Mass.; assignor to Smith and Wesson, Inc.; Springfield, Mass.; a corporation of Massachusetts; Filed Mar. 16, 1961; Ser. No. 96,278; 8 Claims; (Cl. 42–59).

3,125,821; **REPEATING GUN WITH CARTRIDGE LIFTER AND CARTRIDGE STOP MEMBER**; William B. Ruger and Harry H. Sefried II, Southport, Conn.; assignors to Sturm, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Filed Apr. 2, 1962; Ser. No. 184,195; 10 Claims; (Cl. 42–17).

March 24, 1964

3,125,928; **PACKING RING FOR FIREARMS**; Erich Bartels, Ratingen, near Dusseldorf, Germany, assignor to Firma Rheinmetall G.m.b.H., a firm of Germany; Original application Sept. 26, 1960; Ser. No. 58,439; now Patent No. 3,009,937; dated Aug. 6, 1963; Divided and this application June 15, 1962; Serial Number 202,908; Claims priority, application Germany September 26, 1959; 2 Claims; (Cl. 89–26).

3,125,929; **SHOOTING REST**; Howard Peasley, Portville, M.Y. (423 Wygant Road, Horseheads, N.Y.); Filed Mar. 30, 1961; Ser. No. 99,611; 14 Claims; (Cl. 89–37).

3,125,930; **GAS SYSTEM FOR GUN OPERATION**; Earl C. Gilbert, Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed Nov. 7, 1962; Ser. No. 236,170; 4 Claims; (Cl. 89–191); (Granted under Title 35, U.S. Code (1952), sec. 266).

March 31, 1964

3,126,789; **HYPERVELOCITY PROPULSION ARRANGEMENT**; Rodulf X. Meyer, Pacific Palisades, Calif.; assignor to The Aerospace Corporation, Los Angeles, Calif.; a corporation of California; Filed May 17, 1962; Ser. No. 195,513; 14 Claims; (Cl. 89–8).

3,126,790; **FEED BELT BOOSTER WITH DEMAND CONTROL**; Douglas P. Tassie, St. George, and Lewis K. Wetzel, South Burlington, Vt.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Nov. 15, 1962; Ser. No. 238,062; 4 Claims; (Cl. 89–33).

3,126,791; **GUN RECOIL TORQUE ELIMINATOR**; Robert E. Chiabrandy, Burlington, Vermont; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Nov. 15, 1962; Ser. No. 238,063; 5 Claims; (Cl. 89–42).

April 7, 1964

3,127,691; **GAS CONTROL MEANS FOR GRENADE LAUNCHING ATTACHMENTS**; Cyril A. Moore, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 27, 1962; Ser. No. 205,805; 6 Claims; (Cl. 42–1); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,127,812; **GAS SYSTEM FOR FIREARMS**; Henry A. Into, Wallingford, and David F. Butler, Hamden, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed June 14, 1962; Ser. No. 202,510, 6 Claims; (Cl. 89–193).

April 14, 1964

3,128,570; **SAFETY AND DRY-FIRING DEVICE FOR PISTOLS**; Bruce W. Browning, Ogden, Utah; assignor to Browning Industries, Inc.; Ogden, Utah, a corporation of Utah; Filed Sept. 19, 1961; Ser. No. 139,276; 16 Claims; (Cl. 42–70).

3,128,571; HAND GUN STOCK; Steven J. Herrett, Box 741; Twin Falls, Idaho; Filed Feb. 23, 1962; Ser. No. 175,032; 14 Claims; (Cl. 42–71).

3,128,670; FLASHLESS NON-RECOIL GUN AND ROUND; Latham Valentine Stewart Blacker, Coldhayes, Liss, England; Filed Oct. 9, 1961; Ser. No. 143,700; 2 Claims; (Cl. 89–1.7).

April 21, 1964

3,129,636; MEANS FOR LAUNCHING PROJECTILES; Richard G. Strickland, Stewartstown, Pa.; and Arthur J. Wennerstrom; Zurich, Switzerland, assignors to Aircraft Armaments, Inc.; Cockeysville, Md.; a corporation of Maryland; Filed Sept. 28, 1960; Ser. No. 59,014; 3 Claims; (Cl. 89–1.7).

3,129,637; SAFETY SEAR MECHANISM FOR BLOW BACK BREECH ACTION; Charles F. Packard, East Longmeadow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Sept. 17, 1963; Ser. No. 309,579; 7 Claims; (Cl. 89–154); (Granted under Title 35, U.S. Code (1952), sec. 266).

April 28, 1964

3,130,513; BOLT ACTION FIREARM WITH AUTOMATIC SAFETY MECHANISM ENGAGEABLE BY BOLT HANDLE; Oliver M. Knode, Jr.; Hampden, Mass.; assignor to Savage Arms Corporation, Westfield, Mass.; a corporation of Delaware; Filed Oct. 2, 1961; Serial Number 142,162; 7 Claims; (Cl. 42–70).

3,130,638; PROJECTILE TRANSFER MECHANISM; Eugene B. Horton, Jr.; and Bernard A. Niemeier, Richmond, Va.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Oct. 16, 1961; Ser. No. 145,505; 5 Claims; (Cl. 89–33).

3,130,639; GUN CARRIAGES ESPECIALLY FOR ANTI–AIRCRAFT GUNS; Louis Birkigy, Prefny-Geneve, Switzerland; assignor to Brevets Aero-Mecaniques S.A.; Geneva, Switzerland; a society of Switzerland; Filed June 21, 1961; Ser. No. 204,171; Claims priority application Luxembourg June 24, 1961; 7 Claims. (CCl. 89–40).

3,130,640; POSITIVE SHUTOFF VARIABLE RECOIL MECHANISM; Roland A. Magnuson, Seattle, Wash.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Apr. 17, 1962; Ser. No. 188,288; 3 Claims; (Cl. 89–43).

3,130,641; OSCILLATORY MOUNTING IN PARTICULAR FOR AUTOMATIC FIREARMS Bremen, Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed June 29, 1962; Ser. No. 206,394; Claims priority application Germany July 5, 1961; 5 Claims; (Cl. 89–44).

May 5, 1964

3,131,498; FLARE EJECTOR; Marshall G. Coulter, 118 Part St., Tecumseh, Mich,; Filed Mar. 13, 1961; Ser. No. 95,127; 1 Claim; (Cl. 42–1).

3,131,499; ACTION FOR DOUBLE BARREL FIREARMS; Amedee J. Aresnault, Ville Jacques Cartier, Quebec, Canada; Filed Sept. 23, 1963; Ser. No. 310,535; 5 Claims; (Cl. 42–42).

3,131,500; CARTRIDGE LOADER FOR REVOLVERS AND CARRYING CASE THEREFOR; Julien J. Buchwalder, Trumbull, Conn.; assignor to United Eastern Corporation, Trumbull, Conn.; a corporation of Connecticut; Filed Mar. 21, 1961; Ser. No. 97,384; 12 Claims; (Cl. 42–89).

May 19, 1964

3,133,369; FIREARM AND ROTARY MAGAZINE THEREFOR; John L. Boudreau, 655 Short Beach Road, Stratford, Conn.; Filed Jan. 24, 1962; Ser. No. 168,412; 20 Claims; (Cl. 42–19).

May 26, 1964

3,134,301; GUN LOADING APPARATUS; Georges Francois Marie Even, 7 Ave. Pierre Grenier, Boulogne, France; Filed Dec. 12, 1960; Ser. No. 75,165; Claims priority application France Dec. 11, 1959; 3 Claims; (Cl. 89–33).

3,134,302; MOUNTINGS FOR AUTOMATIC WEAPONS; Franz Horn, Dusseldorf-Nord, Germany; assignor to Firma Rheinmetall G.m.n.H.; Dusseldorf, Germany; Filed Dec. 3, 1962; Ser. No. 241,875; Claims priority application Germany Dec. 5, 1961; 3 Claims; (Cl. 89–36).

3,134,303; LOADING PENDULUM ASSEMBLY FOR AN AUTOMATIC GUN; Carl Gustav Ingemar Sahlberg, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish company; Filed Feb. 16, 1962; Ser. No. 173,635; Claims priority, application Sweden Feb. 22, 1961; 4 Cliams. (Cl. 89–45).

June 2, 1964

3,135,064; FIREARM RECOIL PAD; Frank A. Pachmayr, Los Angeles, Calif.; assignor to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed May 21, 1962; Ser. No. 196,056; 6 Claims; (Cl. 42–74).

June 9, 1964

3,136,084; GAS CUTTING PREVENTION IN REVOLVER FIREARMS; Dwayne W. Charron, Chicopee, Mass.; assignor to Smith and Wesson, Inc.; Springfield, Mass.; a corporation of Massachusetts; Filed Mar. 9, 1962; Ser. No. 178,730; 7 Claims; (Cl. 42—59).

3,136,212; EMPTY CASE EJECTOR FOR AUTOMATIC GUN SYSTEMS; Philias H. Girouard, Washington, D.C., Carl V. Hickman, deceased, late of Kensington, Md.; by Jean W. Hickman, administratrix, Washington, D.C.; Garold A. Kane, John I. Nelson, Micton C. Neuman, and Harrison Randolph, Minneapolis, Minn.; and Thomas C. Collier, Portsmouth, M.H.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Navy; Original application August 27, 1952; Serial No. 306,612; Divided and this application July 25, 1958; Ser. No. 754,120; 1 Claim; (Cl. 89—33).

3,136,213; TWO-STAGE TANDEM TYPE FEEDING MECHANISM FOR FIREARMS; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 13, 1963; Ser. No. 280,170; 4 Claims; (Cl. 89—33). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,136,214; GUN MOUNT WITH SHIELD MEANS; Philias H. Girouard, Washington, D.C.; Carl V. Hickman, deceased, late of Kensington, Md.; by Jean W. Hickman, administratrix, Washington, D.C.; Garold A. Kane, John I. Nelson, Milton C. Neuman, and Harrison Randolph, Minneapolis, Minn.; and Thomas C. Collier, Portsmouth, N.H.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Navy; Original application Aug. 27, 1952; Ser. No. 306,612; Divided and this application July 25, 1958; Ser. No. 754,121; 3 Claims; (Cl. 89—36).

3,136,215; STRAFING DEVICE; Steven Kalergios, 91-07 Corona Avenue, Elmhurst, N.Y.; Filed March 5, 1962; Ser. No. 177,273; 2 Claims; (Cl. 89—41).

June 16, 1964

3,137,084; BOLT MECHANISM INCLUDING A PAIR OF EXTRACTORS FOR A FIREARM; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Sept. 10, 1962; Serial No. 222,745; 7 Cliams; (Cl. 42—25). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,137,204; ADJUSTABLE BLANK FIRING ATTACHMENT FOR AUTOMATIC FIREARMS; Earle M. Harvey, Agawam, Mass,; assignor to the United States of America as represented by the Secretary of the Army; Filed May 14, 1963; Ser. No. 280,473; 4 Claims; (Cl. 89—14); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,137,205; DEVICE FOR PROTECTION AGAINST BURSTING PROJECTILES; Sven Erik Berge and Pehr Gunnar Richard Guldbrand Grenander, Stockholm, and Sven Emil Philip, Nasbypark, Sweden; assignors to Aktiebolaget Bofors, Bofors, Sweden, a Swedish Company; Filed March 7, 1960; Ser. No. 13,255; 4 Claims; (Cl. 89—36).

June 23, 1964

3,137,957; SAFETY DEVICE FOR FIREARMS; Bradford W. Ingalls, Baton Rouge, La.; assignor to Frank B. Williams, Metairie, La.; Filed July 19, 1962; Serial Number 211,002; 3 Claims; (Cl. 42—1).

3,137,958; ADJUSTABLE BUTT STOCK; Karl R. Lewis and Bruce W. Browning; Ogden, Utah; assignors to Browning Industries, Inc.; Ogden, Utah; a corporation of Utah; Filed Oct. 29, 1962; Serial Number 234,283; 6 Claims; (Cl. 42—73).

3,138,063; CATAPULT DELIVERY DEVICE; Arthur R. Lardin, Monmouth Mobile Home Park, U.S. Highway 1, Monmouth Junction, N.J.; Filed July 15, 1963; Ser. No. 295,081; 9 Claims; (Cl. 89—1).

June 30, 1964

3,138,888; TRIGGER SAFETY FOR BOLT ACTION RIFLE; Nicholas L. Brewer, deceased, late of Tarpon Springs, Fla.; by Margaret W. Brewer, executrix, Tarpon Springs, Fla.; assignor by mesne assignments to The American Hardware Corporation, a corporation of Connecticut; Original application Nov. 20, 1958; Serial Number 775,143; now Patent No. 3,005,279; dated Oct. 24, 1961; Divided and this application May 12, 1961; Ser. No. 120,822; 9 Claims; (Cl. 42—70).

3,138,889; AUXILIARY GUN BARREL; Lauren F. Groover, Sheakleyville, Pa.; assignor to The Poly-Choke Company, Inc.; East Hartford, Conn.; a corporation of Connecticut; Filed Nov. 15, 1962, Ser. No. 237,833; 8 Claims; (Cl. 42—77).

3,138,990; LIQUID PROPELLANT MACHINE GUN; Roy A. Jukes, Knoxville, Tenn.; and Bernard A. Niemeier, Richmond, Va.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Oct. 9, 1961; Ser. No. 143,983; 3 Claims; (Cl. 89—7).

3,138,991; FIREARM MUZZLE ATTACHMENT AND PROJECTILE WITH EXPANSIBLE DETACHABLE HUSK; Richard L. Malter, 241 Ocean Parkway, New York, N.Y.; Filed Jan. 10, 1962; Ser. No. 165,334; 1 Claim; (Cl. 89—14).

3,138,992; THERMAL PROTECTOR TUBE AND SHIELD; Griffith B. Lewis, Watervliet, N.Y.; assignor to Fulton Fastener Corporation, New York, N.Y.; a corporation of New York; Filed Dec. 12, 1962; Ser. No. 244,146; 9 Claims; (Cl. 89—36).

3,138,994; GUN MOUNT; Robert W. Blunk, Camas, Washington; assignor to the United States of America as represented by the Secretary of the Army; Filed April 18, 1963; Serial Number 274,066; 3 Claims; (Cl. 89—37); (Granted under Title 35, U.S. Code (1952), sec. 266).

July 7, 1964

- 3,139,694; **SAFETY DEVICE FOR FIREARMS**; Edward E. Schaefer, 1534 Park Avenue, River Forest, Ill.; Filed October 30, 1961; Serial Number 148,360; 9 Claims; (Cl. 42–70).
- 3,139,796; **GAS OPERATED FEEDER FOR GUN**; Robert G. Nutting, Glenview, Ill.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed Feb. 24, 1956; Serial Number 567,696; 1 Claim; (Cl. 89–33).
- 3,139,798; **HOIST FOR ROUNDS OF AMMUNITION**; Henry Wilhelm Aldrin, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed Dec. 12, 1962; Serial Number 244,206; Claims priority application Sweden Dec. 23, 1961; 10 Claims; (Cl. 89–46).
- 3,139,799; **ACTION FOR SEMIAUTOMATIC FIREARMS**; Carl H. Benson, New Haven, Conn.; assignor to O.F. Mossberg and Sons, Inc.; New Haven, Conn.; a corporation of Connecticut; Filed April 4, 1962; Serial Number 185,144; 6 Claims; (Cl. 89–197).

July 14, 1964

- 3,140,554; **DOUBLE TANDEM-ARRANGED MAGAZINE FEEDING DEVICE**; Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 10, 1963; Serial Number 286,874; 4 Claims; (Cl. 42–18); (Granted under Title 35, U.S. Code (1952), sec. 266).
- 3,140,638; **FAIRING**; Peter L. De Luca, Elgin, Ill.; assignor to Hawley Produces Company, St. Charles, Ill.; a corporation of Delaware; Filed July 27, 1962; Serial Number 212,944; 10 Claims; (Cl. 89–1.7).
- 3,140,639; **TURRET PLATFORM FOR A REVOLVING-TURRET GUN MOUNTING**; Bruno Werner, Dusseldorf-Gerresheim, Germany, assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed June 3, 1963; Serial Number 284,867; Claims priority, application Germany June 1, 1962; 5 Claims; (Cl. 89–36).

July 21, 1964

- 3,141,254; **AUXILIARY TRIGGER DEVICE WITH SAFETY**; Giulio V. Savioli, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed April 18, 1962; Serial Number 188,591; 4 Claims; (Cl. 42–70). (Granted under Title 35, U.S. Code (1952), sec. 266).
- 3,141,376; **FLAME-OUT ELIMINATOR**; George M. Chinn, 400 Pennsylvania Ave. SE., Washington, D.C.; Filed June 13, 1955; Serial Number 515,268; 3 Claims; (Cl. 89–14). (Granted under Title 35, U.S. Code (1952), sec. 266).
- 3,141,377; **ROUND-TO-BARREL SEALING MECHANISM**; Robert Butterworth, District Heights, Md.; assignor to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Ser. No. 663,326; 4 Claims; (Cl. 89–17); (Granted under Title 35, U.S. Code (1952), sec. 266).

July 28, 1964

- 3,142,125; **EJECTOR FOR SHOTGUN**; Lauren F. Groover, Sheakleyville, Pa.; assignor to The Poly-Choke Company, Inc.; East Hartford, Conn.; a corporation of Connecticut; Filed Dec. 28, 1962; Ser. No. 248,084; 11 Claims; (Cl. 42–47).
- 3,142,126; **TRIGGER GUARD FOR REVOLVER**; Gunter Horst Rohm, Muhlstrasse 9, Sontheim (Brenz), Germany; Filed Nov. 23, 1962; Ser. No. 239,578; Claims priority, application Germany Dec. 14, 1961; 4 Claims; (Cl. 42–65).
- 3,142,225; **CONTROL MEANS FOR UNARMING PROJECTILES**; Robert Apotheloz, Wallisellen, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon, Administration Company, Zurich-Oerlikin, Switzerland; Filed June 22, 1961; Ser. No. 118,999; Claims priority, application Switzerland June 30, 1960; 15 Claims; (Cl. 89–6.5).
- 3,142,226; **LOADING TRAY FOR RECOILING GUN**; Arent Gustav Carlsson, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish corporation; Filed Feb. 12, 1963; Ser. No. 257,999; Claims priority application Sweden Apr. 8, 1959; 7 Claims; (Cl. 89–45).
- 3,142,227; **GUARD FOR CONTROL MEMBER**; Eugene L. Stinger, c/o Aero Services, Inc.; P.O. Box 11043; Emery Park Station, Tucson, Arizona; Filed March 15, 1963; Ser. No. 265,488; 8 Claims; (Cl. 89–136).

August 4, 1964

- 3,142,921; **CARTRIDGE LIFTER MECHANISM FOR SEMI-AUTOMATIC GUN**; William B. Ruger, Southport, Conn.; assignor to Sturm, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Filed Mar. 1, 1961; Ser. No. 106,991; 8 Claims; (Cl. 42–17).
- 3,142,922; **REPEATING FIREARM**; William B. Ruger, Southport, Conn.; assignor to Sturm, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Filed May 4, 1962; Ser. No. 192,552; 6 Claims; (Cl. 42–17).
- 3,142,923; **BOLT ASSEMBLY COMPRISING A PIVOTED FIRING PIN SERVING ALSO AS THE EJECTOR AND AN EXTRACTOR**; Edwin S. Vartanian, North Haven, and Joseph A. Badall, Branford, Conn.; assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Mar. 12, 1962; Ser. No. 178,972; 7 Claims; (Cl. 42–25).
- 3,142,924; **SINGLE-SHOT WITH LATERALLY SWINGING BREECHBLOCK**; William B. Ruger and Harry H. Sefried II, Southport, Conn.; assignors to Sturm, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Filed June 18, 1962; Ser. No. 203,033; 5 Claims; (Cl. 42–32).

3,142,925; **DOUBLE-BARRELED SINGLE-TRIGGER FIREARM**; Allen N. Miller, 1002 S. Orchard, Boise, Idaho; Filed July 8, 1963; Ser. No. 293,310; 14 Claims; (Cl. 42–42).

3,142,926; **TRIGGER WITH ADJUSTABLE SCREW AND STUD THEREIN**; Edward L. Morrow, Fairfield, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed June 27, 1962; Ser. No. 205,612; 5 Claims; (Cl. 42–69).

3,143,038; **APPARATUS FOR FEEDING AN AMMUNITION BELT TO A RAPID-FIRE CANNON**; Hans Joachim Rubsam, Neuss (Rhine), Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed June 19, 1963; Ser. No. 289,028; Claims priority, application Germany June 23, 1962; 4 Claims; (Cl. 89–33).

August 11, 1964

3,143,818; **BOLT-LOCK-RECEIVER AND BARREL ASSEMBLY**; Edwin S. Vartanian, North Haven, and Joseph A. Badali, Branford, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed May 1, 1962; Ser. No. 191,531; 10 Claims; (Cl. 42–21).

3,143,819; **MAGAZINE FOR PISTOL**; Frederick F. Stevens, Jr.; Lane's Pond Road, Northford, Conn.; Original application Dec. 6, 1957; Ser. No. 701,035; now Patent No. 3,069,976; Dated Dec. 25, 1962; Divided and this application Dec. 10, 1962; Ser. No. 243,500; 4 Claims; (Cl. 42–50).

3,143,820; **RIFLE MAGAZINE ASSEMBLY**; John J. Lucianetti, Edward R. Hirsekorn, and Robert R. Burgess, Jr.; Philadelphia, Pa.; and William J. Rose, Cumberland, Md.; assignors to the United States of America as represented by the Secretary of the Army; Field June 14, 1963; Ser. No. 288,059; 1 Claim; (Cl. 42–50). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,143,922; **VANE TYPE ROTARY MOTOR FOR GUN**; Samuel Altschuler, Woodland Hills, Calif.; and Wayne F. Ridenour, Chicago, Ill.; assignors by mesme assignments to the United States of America as represented by the Secretary of the Army; Filed May 31, 1962; Ser. No. 199,581; 4 Claims; (Cl. 89–12).

August 18, 1964

3,144,727; **EXTRACTOR AND DEFORMABLE PLASTIC CARTRIDGE**; Charles J. De Caro, Orange, Conn.; and Rowland J. Kopf, Rocky River, Ohio; assignors to Olin Mathieson Chemical Corporation; a corporation of Virignia; Original application Jan. 31, 1956; Ser. No. 562,444; now Patent No. 3,018,849; dated Aug. 14, 1962; Ser. No. 217,513; 5 Claims; (Cl. 42–25).

3,144,808; **RECOILLESS RIFLE FIRING MECHANISM**; Wzlter B. Stapp, Fair Oaks, Calif.; and Francis W. Dietsch, Levittown, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed Sept. 11, 1962; Ser. No. 222,977; 5 Claims; (Cl. 89–1.7).

3,144,809; **BREECH BLOCK OPERATING MECHANISM**; Philias H. Girouard, Washington, D.C.; Carl V. Hickman, deceased, late of Kensington, Md.; by Jean W. Hickman, administratrix, Wshington, D.C.; Garold A. Kane, John I. Nelson, Milton C. Neuman, and Harrison Randolph, Minneapolis, Minn.; and Thomas C. Collier, Portsmouth, N.H.; assignors by direct and mesne assignments, to the United States of America as represented by the Secretary of the Navy; original application Aug. 27, 1952; Ser. No. 306,612; Divided and this application July 9, 1958; Ser. No. 750,844; 2 Claims; (Cl. 89–4).

3,144,810; **AUTOMATIC FEED AND CONTROL MECHANISM**; Arthur J. Stanton, Bethesda, Md., David F. Anderson, McLean, Va., Richard E. Taylor, Hyattsville, and Robert Butterworth, District Heights, Md.; and Russel I T. Shawen, Arlington, Va.; assignors to the United States of America as represented by the Secretary of the Navy; Filad June 3, 1957; Ser. No. 663,322; 12 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

August 25, 1964

3,145,494; **MUZZLE-TRIGGERED GUN**; Charles E. Wilcox, 451 N. Doheny Drive, Beverly Hills, Calif. and Donald G. Setty, 1632 Mountcrest Drive, Los Angeles 69, Calif.; Filed July 22, 1963; Ser. No. 296,802; 4 Claims; (Cl. 42–1).

3,145,495; **EXCHANGEABLE REVOLVER CYLINDER AND CARTRIDGE INDEXING DEVICE**; David L. Katz, Longmeadow, and Cyril A. Moore, Springfield, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed July 6, 1962; Ser. No. 208,148; 4 Claims; (Cl. 42–59). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,145,496; **TRIGGER MECHANISM**; Edward L. Morrow, Fairfield, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed July 11, 1963; Ser. No. 294,441; 4 Claims; (Cl. 42–69).

3,145,618; **RAMMER MECHANISM FOR A LOADER**; Richard C. Wilson, Champlin, Minn.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Navy; original application Oct. 22, 1959; Ser. No. 848,163; Divided and this application Nov. 30, 1959; Ser. No. 856,319; 7 Claims; (Cl. 89–1.7).

September 1, 1964

3,146,671; **BREECH BLOCK AND EJECTOR ASSEMBLY**; Philias H. Girouard, Washington, D.C., Carl V. Hickman, Deceased, late of Kensington, Md., by Jean Wil Hichman, administratrix, Washington, D.C., Garold A. Kane, John I. Nelson, Milton C. Neumann, and Harrison Randolph, Minneapolis, Minn,. and Thomas C. Collier, Portsmouth, N.H.; assignors by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Original application Aug, 27, 1952; Ser. No. 306,612; Divided and this application July 9, 1958; Ser. No. 750,843; 6 Claims; (Cl. 89–24).

3,146,672; MEANS FOR CHARGING HYDRAULIC SYSTEMS FOR GUNS; Philian H. Girouard, Washington, D.C., Carl V. Hickman, deceased, late of Kensington, Md., by Jean W. Hickman, administratrix, Washington, D.C., Garold A. Kane, John I. Nelson, Milton C. Neuman, and Harrison Randolph, Minneapolis, Minn., and Thomas C. Collier, Portsmouth, N.H.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Navy; Original application Aug. 27, 1952; Ser. No. 306,612; Divided and this application July 25, 1958; Ser. No. 754,122; 4 Claims; (Cl. 89–43).

3,146,673; MEANS FOR INDEXING MULTIPROJECTILE CARTRIDGES INTO FIRING ALIGNMENT IN A MULTIBORE GUN; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 18, 1963; Ser. No. 296,137; 7 Claims; (Cl. 89–126), (Granted under Title 35, U.S. Code (1952), sec. 266).

September 8, 1964

3,147,562; REINFORCED RECOIL PAD FOR SHOULDER FIREARMS; Frank A. Pachmayr and Edward B. Miller, Culver City, and Lloyd L. Huskey, Alhambra, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, California; a corporation of California; Filed June 25, 1962; Ser. No. 204,816; 10 Claims; (Cl. 42–74).

September 15, 1964

3,148,472; SUBCALIBER PROJECTILE AND SABOT FOR HIGH VELOCITY FIREARMS; Edward N. Hegge, Walpole, and John P. McDonough, Concord, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed June 11, 1962; Ser. No. 201,739; 7 Claims; (Cl. 42–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,148,587; MAGNETOHYDRODYNAMIC HYPER-VELOCITY GUN; Leonard J. Melhart, 6511 Abbington Drive, Oxon Hill 21, Md.; Filed June 27, 1962; Ser. No. 205,804; 1 Claim; (Cl. 89–8). (Granted under Title 35, U.S. Code (1952), sec. 266).

September 22, 1964

3,149,531; AERODYNAMIC COUNTERWEIGHT; Daniel D. Musgrave, 8201 Caraway St., Cabin John, Md.; Filed March 4, 1963; Ser. No. 262,791; 2 Claims; (Cl. 89–1.7).

3,149,532; SMOKE AND FLASH REDUCER; Alan R. Pittaway, Overland Park, Kansas, and Stanley F. Matthews, Cumberland, Md.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed June 11, 1963; Ser. No. 287,158; 1 Claim. (Cl. 89–14).

September 29, 1964

3,150,458; FIREARM WITH DETACHABLE BARREL MOUNTING; Bruce W. Browning, Ogden, Utah, assignor to Browning Industries, Inc.; Ogden, Utah; a corporation of Utah; Filed Dec. 11, 1961; Ser. No. 158,316; 9 Claims; (Cl. 42–75).

3,150,459; REVOLVER LOADER; Ivan Van Scholck, 2281 W. Loncoln, Birminghan, Mich.; Filed July 10, 1961; Ser. No. 123,004; 2 Claims; (Cl. 42–89).

3,150,560; AUTOMATIC OPENING DEVICE; Sidney Rosenthal, West Newton, Mass.; assignor to the United States of America as represented by the Secretary of the Air Force; Filed Jan. 9, 1964; Ser. No. 336,846; 6 Claims; *Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

October 6, 1964

3,151,412; FIREARM BARREL WITH GROOVES AND PROJECTILE WITH FINS FITTING IN SAID GROOVES; Kenneth C. Swindle, South El Monte, Calif.; assignor to Jack Spencer, Big Bear Lake, Calif.; Filed Jan. 2, 1962, Ser. No. 163,657; 4 Cliams; (Cl. 42–76).

October 13, 1964

3,152,417; GAS AXE; Carl R. Weinert, Pittsburgh, Pa.; assignor to Federal Laboratories, Inc.; Saltsburg, Pa.; a corporation of Pennsylvania; Filed March 29, 1963; Ser. No. 269,024; 9 Claims; (Cl. 42–1).

3,152,418; SINGLE OR DOUBLE ACTION FIREARM; Dwayne W. Charron, Chicopee, Mass.; assignor to Smith and Wesson, Inc.; Springfield, Mass.; a corporation of Massachusetts; Filed Mar. 9, 1962; Ser. No. 178,728; 4 Claims; (Cl. 42–69).

3,152,510; RECOIL CONTROLLING DEVICE; Clifford L. Ashbrook, 5027 Cheena St.; and Wilson G. Wing, 33 E Rivercrest Drive, both of Houston, Texas; Filed May 1, 1962; Ser. No. 191,513; 1 Claim; (Cl. 89–14).

3,152,511; GUN EJECTION MECHANISM; Arthur J. Stanton, Bethesda, Md.; David F. Anderson, McLean, Va.; and George B. Boniface, Parkland, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Ser. No. 663,321; 10 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,152,512; PUSHTHROUGH-TYPE CARTRIDGE BELT LINK WITH A BOLT ACTUATED CARTRIDGE RETAINING LATCH South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 13, 1961; Ser. No. 123,906; 2 Cliams; (Cl. 89–35). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,152,513; FIRING MECHANISM WITH BURST CONTROL; Richard H. Colby, South Hadley, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Aug. 13, 1963; Ser. No. 301,924; 3 Claims; (Cl. 89–140). (Granted under Title 35, U.S. Code (1952), sec. 266).

October 20, 1964

3,153,295; RECEIVER-BARREL ASSEMBLY WITH STOCK AND TRIGGER HOUSING; Harold D. Allyn, 10 Sumner Ave., Springfield, Mass.; Continuation of application Ser. No. 814,219; May 19, 1959; now Patent No. 3,079,718; dated May 19, 1959; now Patent No. 3,079,718; dated March 15, 1963; This application September 18, 1961; Ser. No. 138,831; 8 Claims; (Cl. 42–75).

3,153,296; GUN UNLOADERS; Gerald A. Hofstetter, 17720 Bolter Lane, Brookfield, Wis.; Filed Oct. 10, 1962; Ser. No. 229,595; 1 Claim; (Cl. 42–87).

3,153,368; AMMUNITION TRANSFER MECHANISM; Arthur J. Stanton, Bethesda, Md.; David F. Anderson, McLean, and Russell T. Shawen, Arlington, Va.; and John B. King, Riverside, Calif.; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Ser. No. 663,317; 5 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

October 27, 1964

3,153,873; ADJUSTABLE PISTOL SIGHT WITH SPLIT CYLINDRICAL SLEEVE; John L. Boudreau, 655 Short Beach Road, Stratford, Conn.; Original application July 5, 1960; Ser. No. 40,582; now Patent No. 3,088,378; dated May 7, 1963; Divided and this application Sept. 5, 1962; Ser. No. 221,579; 3 Claims; (Cl. 42)1).

3,153,874; HINGED BARREL FIREARM WITH TRIGGER SAFETY MEANS; Rex Raymond Merrill, 1853 8th Ave. N., Fort Dodge, Iowa; Filed Aug. 1, 1962; Ser. No. 214,043; 6 Claims; (Cl. 42–41).

3,153,981; RECEIVER FOR SPENT SHELLS; William D. Brass, 6202 SE 21st Ave., Portland, Oregon; Filed July 2, 1963; Ser. No. 292,297; 6 Claims. (Cl. 89–33).

3,153,982; BREECH MECHANISM FOR AUTOMATIC WEAPONS; Paul Seifried, Oberweller, Weilermatt, Badenweiler, Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed Nov. 8, 1962; Ser. No. 236,232; 14 Claims; (Cl. 89–194).

November 3, 1964

3,154,874; GUN LOCK; Albert R. Steward 4920 Wilshire Blvd., Lincoln, Nebraska; Filed March 26, 1963; Serial Number 268,534; 1 Claim. (Cl. 42–1).

3,155,003; FIREARM ACCESSORY FOR ATTACHMENT TO MUZZLE OF BARREL; John H. Ruth, 229 Lawrence St.; Columbia, Pa.; Filed April 18, 1962; Ser. No. 188,388; 11 Claims. (Cl. 89–14).

3,155,004; SINGLE SHOT OR SEMI-AUTOMATIC FIREARM; Roy E. Weatherby and Fred L. Jennie, both of 271 Firestone Blvd., South Gate, Calif.; Filed Jan. 10, 1963; Ser. No. 250,549; 4 Cliams; (Cl. 89–128).

November 10, 1964

3,156,059; GRIP HOLDER FOR PISTOLS; Robert E. Crain, 1524 NW 29, Oklahoma City, Okla; Filed Nov. 26, 1962; Ser. No. 240,047; 2 Cliams; (Cl. 42–71).

3,156,060; SHOTGUN CHOKE; Frank A. Pachmayr, Los Angeles, Calif.; assignor to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed Dec. 26, 1962; Ser. No. 247,080; 5 Claims. (Cl. 42–79).

3,156,061; INERTIA OPERATED AUTOMATIC SHOTGUN CHOKE; Walton B. Evans, Newalla, Okla.; (420 S. Highland Ave., Midwest City, Okla.); Filed Mar 11, 1963, Ser. No. 264,353; 4 Claims. (Cl. 42–79).

3,156,062; GUN REST; Ralph Maxwell Stevenson, 2010 Union Bank Bldg., Pittsburgh, Pa.; and Emil W. Knight, Slippery Rock, Pa.; Filed Nov. 20, 1963; Ser. No. 325,040; 4 Claims. (Cl. 42–94).

3,156,153; ROLLER BEARING MOUNTED BARREL FOR A MACHINE GUN; John L. Lockhead, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Oct. 16, 1963; Ser. No. 316,780; 1 Claim. (Cl. 89–14). (Granted under Title 35, U.S. Code (1952), sec. 266).

November 17, 1964

3,156,991; EJECTED SHELL RECEPTACLE; Laverne G. Adams, 105 N. Smith St., Greenville, Mich.; Filed Apr. 17, 1962; Ser. No. 188,055; 3 Claims; (Cl. 42–1).

3,156,922; COMBINATION GAS-OPERATED FIREARM AND BOMB OR GRENADE THROWER; Pier Carlo Beretta, Gardone Val Trompia, Brescia, Italy, assingor to Fabbrica D'Armi P. Beretta S.p.A., Gardone Val Trompia, Brescia, Italy; a company of Italy; Filed Sept. 18, 1962; Ser. No. 224,398; Claims priority, application Italy, Sept. 29, 1961; 17,659/61; 2 Claims. (Cl. 42–1).

3,156,993;

3,156,922; **COMBINATION GAS-OPERATED FIREARM AND BOMB OR GRENADE THROWER;** Pier Carlo Beretta, Gardone Val Trompia, Brescia, Italy, assignor to Fabbrica D'Armi P. Beretta S.p.A., Gardone Val Trompia, Brescia, Italy; a company of Italy; Filed Sept. 18, 1962; Ser. No. 224,398; Claims priority, application Italy, Sept. 29, 1961; 17,659/61; 2 Claims. (Cl. 42–1).

3,156,993; **FIREARM BOLT-SLIDE ARM ASSEMBLY;** Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Sept. 24, 1963, Ser. No. 311,101; 7 Claims. (Cl. 42–17).

3,156,994; **EJECTING MECHANISM FOR SHOTGUNS;** Frederic Damon, 13 Cours Fauriel, Saint-Etienne, France; Filed Sept. 23, 1963; Ser. No. 310,618; Claims priority, application France, Oct. 2, 1962; 42,920; Patent 1,342,930; 3 Claims; (Cl. 42–47).

3,156,995; **SHOTGUN GAUGE ADAPTER;** Erwin T. Mellor, Chicopee Falls, and John P. Konsevich, Chicopee, Mass.; assignors to Emhart Corporation, a corporation of Connecticut; Filed Feb. 26, 1963; Ser. No. 261,042; 3 Claims. (Cl. 42–77).

3,157,090; **ARMOR PLATE;** Louis Henry Denys Marie Bally, Epernay, Champfleury, France; Filed Feb. 9, 1961; Ser. No. 88.012; 5 Claims. (Cl. 89–36).

November 24, 1964

3,157,957; **BODY BORNE CHARGE FIRING ARRANGEMENT;** Samuel Lewis 670 Riverside Drive, Apt. 4G, New York, N.Y.; Filed Apr. 12, 1963, Ser. No. 272,638; 4 Claims; (Cl. 42–1).

3,157,958; **HAMMER SAFETY FOR FIREARMS;** Karl R. Lewis, Ogden, Utah; assignor to Browning Industries, Inc.; Ogden, Utah; Filed Feb. 27, 1963; Ser. No. 261,336; 8 Claims. (Cl. 42–70).

3,158,060; **WAFER SWITCH HAVING QUICK RELEASE CONNECTOR;** Robert H. Semenoff, Silver Spring, and William J. Donahue, Takoma Park, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed Nov. 2, 1961; Ser. No. 149,792; 8 Claims; (Cl. 89–1.5). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,158,063; **SEAR AND TRIGGER MECHANISM;** David F. Anderson, McLean, Va.; and Robert Butterworth, District Heights, and Richard E. Taylor, Hyattsville, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Ser. No. 663,318; 4 Claims; (Cl. 89–137); (Granted under Title 35, U.S. Code (1952), sec. 266).

3,158,064; **FIREARM WITH A PIVOTABLE BARREL HAVING A SPHERICAL HUMP ENGAGING A SLIDE MEMBER;** Dwayne W. Charron, Chicipee, Mass.; assignor to Smith and Wesson, Inc.; Springfield, Mass.; a corporation of Massachusetts; Filed Jan. 23, 1962; Ser. No. 168,187; 5 Claims; (Cl. 89–196).

December 1, 1964

3,158,947; **MAGAZINE FOR FIREARMS;** Hartmut Menneking and Hermann Henning; Dusseldorf, Germany; assignors to Firma Rheinmetall G.m.b.J.; Dusseldorf, Germany; Filed Mar. 28, 1963; Ser. No. 268,808; Claims priority, application Germany; March 31, 1962; R 32,400; 3 Claims; (Cl. 42–50).

3,158,948; **REVOLVER FIRING ACTION MEANS;** George H. Freed, Blooningfield Ave, Pine Brook, N.J.; Filed Feb. 28, 1962; Ser. No. 176,224; 15 Claims; (Cl. 42–65).

3,158,949; **REVOLVER FIRING ACTION MEANS;** George H. Freed, Bloomfield, Ave., Pine Brook, N.J.; Filed Feb. 28, 1962; Ser. No. 176,235; 22 Claims; (Cl. 42–65).

3,158,950; **FIRING MECHANISM FOR REVOLVERS;** George H. Freed, Bloomfield, Ave., Pine Brook, N.J.; Filed Oct. 16, 1961; Ser. No. 145,258; 30 Claims; (Cl. 42–65).

3,159,079; **BALL-AND-SOCKET JOINT TYPE MOUNTING FOR AUTOMATIC FIREARMS;** Walter Heldebrand, Neus (Rhine), Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed Jan. 19, 1961; Ser. No. 83,608; Claims priority, Application Germany, Jan. 20, 1960; R 27,140; 2 Claims; (Cl. 89–37).

3,159,080; **GUN SAFETY CATCH ACTUATING MEANS;** George H. Freed, Bloomfield Ave., Pine Brook, N.J.; Filed April 4, 1961; Serial Number 100,633; 5 Claims; (Cl. 89–148).

December 8, 1964

3,159,938; **GAS SEAL FOR ROTATABLE CARTRIDGE DRUM;** John W. Treat, Jr. East Hampton, Conn.; Robert L. Hall, Marblehead, Mass., and Robert F. Robinson, Montor, Conn., assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed July 27, 1962; Serial Number 213,064; 7 Claims; (Cl. 42–59).

3,160,063; **OPERATING MECHANISM FOR SALVO-TYPE GUNS;** Robert F. Magardo, Springfield, and Donald C. Dadmun, Northampton, Mass.; assignors to the United States of America as represented by the Secretary of the Army; Filed Dec. 27, 1962; Ser. No. 247,772; 9 Claims; (Cl. 89–127). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,160,064; **LIQUID PROPELLANT GUN;** Charles R. Bell, Canoga Park, Calif., and Kenneth G. Johnson, Aurora, Ill.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed May 27, 1957; Serial Number 661,983; 2 Claims; (Cl. 89–155).

December 15, 1964

3,160,976; **GUN RECOIL PAD**; Frank A. Pachmayr, Los Angeles, Calif.; assignor to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed May 21, 1962; Serial Number 196,124; 1 Claim. (Cl. 42–74).

December 22, 1964

3,161,977; **BREECH BLOCK LOCKING BOLT FOR A GUN**; Jay P. Jarvis, North Branford, and Edwin S. Vartanian, North Haven, Conn.; assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed Dec. 26, 1963, Serial Number 333,304; 12 Claims. (CL. 42–21).

3,161,978; **TORSION BAR CARTRIDGE EXTRACTOR**; John F. O'brien, Springfield, Mass.; and Edward A. Santos, Enfield, Conn.; assignors to the United States of America as represented by the Secretary of the Army; Filed Jan. 2, 1964; Serial Number 335,442; 5 Claims; (Cl. 42–25). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,161,979; **ADJUSTABLE SHOTGUN CHOKE DEVICE**; Charles E. Lowe, West Hartford, Conn.; assignor to Hartford Gun Choke, Co., Inc.; Newington, Conn.; a corporation of Connecticut; Filed Aug. 11, 1961; Serial Number 130,905; 2 Claims; (Cl. 42–79).

December 29, 1964

3,162,966; **HANDGUN STABILIZER**; Gregory M. La Coss, Falls Church, Va.; assignor to La Coss Corporation, Falls Church, Va.; Filed Oct. 25, 1962; Serial Number 232,981; 2 Claims; (Cl. 42–72).

January 5, 1965

- **3,163,950; MAGAZINE TUBE-RECEIVER JOINT STRUCTURE**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed April 1, 1963; Serial Number 269,516; 7 Claims; (Cl. 42–49).
- **3,163,951; FIREARM FIRING MECHANISM**; Karl R. Lewis, 2450 Grant Avenue; Ogden, Utah; Filed Nov. 23, 1960; Serial Number 71,339; 43 Claims; (Cl. 42–65).
- **3,163,952; BARREL-RECEIVER MOUNTING FOR FIREARMS**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed May 24, 1963; Serial Number 282,988; 5 Claims; (Cl. 42–75).
- **3,163,953; EXTENSION FOR SHOTGUN BARREL**; Edward W. Bridge, Sr., 1507 Foulkrod St., Philadelphia, Pa.; Filed March 23, 1964; Serial Number 353,814; 10 Claims; (Cl. 42–79).
- **3,164,060; GUN RECOIL, FLASH AND SOUND REDUCER ASSEMBLY**; Edwin G. Dahl, Rte. 2, Billings, Montana; Filed Feb. 20, 1963; Serial Number 259,811; 6 Claims; (Cl. 89–14).

January 12, 1965

- **3,164,919; FIREARM TRIGGER LOCK**; Robert L. Hall, 3318 W. Burbank Blvd., Burbank, California; Filed Sept. 28, 1962; Serial Number 226,989; 1 Claim; (Cl. 42–70).
- **3,164,920; HANDGRIP FOR GUNS**; Charles P. Hans, Jr.; 1447 S. Jones Blvd, Apt. 206E, and Willard E. Roebuck, 4164 E. Paseo Grande, both of Tucson, Ariz.; Filed Dec. 31, 1962; Serial Number 248,442; 10 Claims; (Cl. 42–71).

January 19, 1965

- **3,165,849; MAGAZINE CUTOFFS**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed November 28, 1962; Serial Number 240,586; 6 Claims; (Cl. 42–17).
- **3,165,850; FIREARMS**; Hector Mendoza Orozco, Bartolacho 1914; Mexico City, Mexico; Filed November 19, 1962; Serial Number 238,468; 3 Claims; (Cl. 42–34).
- **3,165,851; FIRING MECHANISM FOR MULTIPLE BARREL FIREARMS**; Glen L. Mittelsteadt, Waseca, Minn.; assignor to Herter's Inc.; Waseca, Minn.; a corporation of Minnesota; Filed May 13, 1963; Serial Number 279,756; 5 Claims; (Cl. 42–42).
- **3,165,852; AUXILIARY SPRING FOR A TUBULAR MAGAZINE**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virignia; Filed September 25, 1963; Serial Number 311,366; 6 Claims (Cl. 42–49).
- **3,165,972; GYRO WEAPONS STABILIZER**; Harold B. Cumbo, 1757 NE. 35th Street, Fort Lauderdale, Florida; Filed October 28, 1963; Serial Number 319,467; 2 Claims; (Cl. 89–14).
- **3,165,973; MANNER OF MOUNTING HEAVY ARMS IN VEHICLES**; Kurt Bobrmann, Kassel, Germany, assignor to Henschel-Werke A.G.; Kassel, Germany; a corporation of Germany; Filed March 12, 1963; Serial Number 264,498; Claims priority; application Germany March 13, 1962; 6 Claims. (Cl. 89–40).

January 26, 1965

- **3,166,864; OBTURATOR FOR SMALL ARMS**; John J. Scanlon, Jr.; Levittown, N.J.; assignor to the United States of America as represented by the Secretary of the Army; Filed August 1, 1963; Serial Number 299,437; 3 Claims; (Cl. 42–16). (Granted under Title 35, U.S. Code (1952), sec. 266).
- **3,166,865; GUN CHOKE**; Arne Y. Grahn, Granby, Conn.; assignor to The Poly Choke Company, Inc.; Hartford, Conn.; a corporation of Connecticut; Filed Sept. 30, 1963; Serial Number 312,645; 7 Claims; (Cl. 42–79).
- **3,166,982; LOADER MECHANISM**; Arthur J. Stanton, Bethesda, Md.; David F. Anderson, McLean, Va.; and Richard E. Taylor, Hyattsville, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Serial Number 663,324; 11 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).
- **3,166,983; DIFFERENTIAL GAS SYSTEM FOR GAS-OPERATED FIREARMS**; Albert J. Lizza, North Wilbraham, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Sept. 18, 1963; Serial Number 309,902; 3 Claims; (Cl. 89–191). (Granted under Title 35, U.S. Code (1952), sec. 266).

February 2, 1965

- **3,167,875; HAND PROTECTOR AND GUNSTOCK CARRIER**; Norma. T. Winner, 13 Rorer Avenue, Hatboro, Pa.; and Elton Lindsey, 10 Fern Avenue, Willow Grove, Pa.; said Lindsey assignor of forty percent to Rovert J. Curtis, Willow Grove, Pa.; Filed May 18, 1964; Serial Number 368,008; 10 Claims; (Cl. 42–1).
- **3,167,876; HANDGUN**; John M. Milroy, Jr.; Wilson, Va.; (211 High St., Blackstone, Va); Filed October 19, 1960; Serial Number 63,656; 15 Claims; (Cl. 42–7).
- **3,167,877; TRIGGER MECHANISM FOR A FIREARM**; Friedhelm G. Jungeling, Amsterdam, Netherlands, assignor to Staatsbedrijf Artillerie-Inrichtingen, Hembrug-Zaandam, Netherlands, a corporation of the Netherlands; Filed November 8, 1962; Serial Number 236,351; Claims priority, application Netherlands, November 22, 1961; 271,660; 3 Claims; (Cl. 42–69).

February 9, 1965

3,168,788; **SIGNAL PISTOL**; Marshall G. Coulter, 118 Park Street, Tecumseh, Michigan; Filed April 5, 1963; Serial Number 270,996; 4 Claims; (Cl. 42–1).

February 16, 1965

3,169,333; **PROJECTILE FOR FIRING A LEAKPROOF CASELESS ROUND**; John H. Scanlon, Jr., Levittown, N.J.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 14, 1963; Serial Number 288,057; 4 Claims. (Cl. 42–69). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,169,443; **PROPELLANT ACTUATED RELEASE BOLT**; Albert M. Stott, Clifton Heights, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 20, 1962; Serial Number 211,462; 1 Claim; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,169,445; **MAGAZINE MECHANISM**; Arthur J. Stanton, Bethesda, Maryland, David F. Anderson, McLean, Va.; Richard E. Taylor, Hyattsville, Md.; and John B. King, Riverside, California; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Serial Number 663,325; 11 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

February 23, 1965

3,170,261; **REVOLVING FIREARM**; Luigi Ludovici, 1 Cia Celestino V, L'Aquila, Italy; Filed September 23, 1963; Serial Number 310,596; 3 Claims; (Cl. 42–59).

3,170,372; **LOADER AND MAGAZINE MECHANISM**; Arthur J. Stanton, Bethesda, Md.; David F. Anderson, McLean, Va.; and Richard E. Taylor, Hyattsville, Md.; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Serial Number 663,323; 14 Claims. (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

March 2, 1965

3,171,224; **DEVICE FOR FACILITATING THE REMOVAL OF EXPLOSIVE CARTRIDGES**; William F. Broske, Camp Hill, Pa.; assignor to AMP Incorporated, Harrisburg, Pa.; Filed January 8, 1962; Serial Number 164,756; 3 Claims; (Cl. 42–1).

3,171,225; **AUTOMATIC SHOTGUN**; Frank T. Green and Wilfred I. Smith, Haydenville, Mass.; assignors to Noble Manufacturing Company, Inc.; Haydenville, Mass.; a corporation of Massachusetts; Filed May 10, 1963, Serial Number 279,391; 8 Claims; (Cl. 42–17).

3,171,226; **FIREARM VENTILATED SIGHT RIB WITH A DOVETAIL KEY**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed June 12, 1963; Serial Number 287,316; 6 Claims. (Cl. 42–76).

3,171,325; **GUN MOUNTINGS**; Roy Gilbert Vickers, Grantham, England, assignor to Brevets Aero-Mecaniques S.A.; Geneva, Switzerland; a society of Switzerland; Filed April 22, 1963; Serial Number 274,568; Claims priority Application Great Britain; April 30, 1962; 16,361/62; 4 Claims. (Cl. 89–40).

3,171,326; **RECOIL FRICTION BRAKE FOR AUTOMATIC FIREARMS**; Vance A. Baker, Box 465; Norfolk, Nebraska; assignor of sixty percent to Charles H. Baker, Wichita, Kansas; Filed March 29, 1962; Serial Number 183,614; 25 Claims; (Cl. 89–177).

March 9, 1965

3,172,222; **SELF-LOCKING CARRIER**; Edwin S. Vartanian, North Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed Jan. 7, 1964; Serial Number 336,213; 8 Claims; (Cl. 42–21).

March 16, 1965

3,173,221; **REVOLVER CYLINDERS FOR MULTIPLE CALIBERS**; Jessie T. Ivy, 523 Henderson St. S., Seattle, Wash.; Filed March 4, 1963; Serial Number 262,764; 2 Claims; (Cl. 42–65).

3,173,333; **VEHICLE EJECTION SEATS**; James Martin, Southlands Manor, Southlands Road,Denham, near Uxbridge, Middlesex, England; Filed Feb. 15, 1963; Serial Number 258,831; Claims priority; application Great Britain; February 16, 1962; 5,990/62; 3 Claims; (Cl. 89–1).

March 23, 1965

3,174,399; **FIRING MECHANISM FOR AUTOMATIC FIREARMS**; Hans Brieger, Zurich, Switzerland; assignor to Machine Tool Works Oerlikon Administration Company; Zurich-Oerlikon, Switzerland; Filed Feb. 8, 1962; Serial Number 171,874; Claims priority, application Switzerland, Feb. 13, 1961; 1,697/61; 4 Claims; (Cl. 89–132).

3,174,400; SERVO-TRIGGER MECHANISMS FOR AUTOMATIC FIREARMS OF THE OPEN BREECH TYPE; Bernard Maillard; Geneva, Switzerland; assignor to Brevets Aero-Mecaniques SA.; Geneva, Switzerland; a society of Switzerland; Filed November 26, 1962; Serial Number 239,882; Claims priority; application Luxembourg, November 30, 1961; 40,889); 4 Claims; (Cl. 89–149).

3,174,401; ACTUATING MECHANISM FOR AUTOMATIC SHOTGUN; Pier Carlo Beretta, Via Siepi 6, Gardone Val Trompia, Brescia, Italy; Filed December 20, 1961; Serial Number 160,849; Claims priority; Application Italy, January 20, 1961; 642,730; June 10, 1961; 10,720/1; 4 Claims; (Cl. 89–192).

March 30, 1965

3,175,464; SAFETY BRAKE MECHANISM FOR EXTERNALLY POWERED AUTOMATIC GUN; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed September 18, 1962; Serial Number 224,565; 9 Claims; (Cl. 89–161); (Granted under Title 35, U.S. Code (1952), sec. 266).

April 6, 1965

3,176,422; ANTI-JAMMING MEANS FOR REVOLVERS; Harlan N. Harris, Los Angeles, Calif.; (9981 Pall Ave., Tujunga, Calif.); Filed February 28, 1962; Serial Number 176,288; 1 Claim; (Cl. 42–59).

3,176,423; REVOLVER FIRING MECHANISM; Eugene E. Geber, 1908 Douglas Street, Rockford, Ill.; Filed June 20, 1962; Serial Number 203,948; 3 Claims; (Cl. 42–65).

3,176,424; RECOIL ABSORBING STOCK ASSEMBLY; Ralph O. Hoge, 1352 N. Alta Vista Blvd.; Los Angeles, Calif.; Filed June 6, 1963; Serial Number 286,018; 10 Claims; (Cl. 42–74).

April 13, 1965

3,177,601; BOLT STOP FOR USE WITH TANDEM-TYPE MAGAZINES; Robert Meunier, New Bedford, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Dec. 18, 1963; Serial Number 331,633; 3 Claims; (Cl. 42–18). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,177,602; REVOLVER CYLINDER AND SPINDLE; Eugene E. Geber, 1908 Douglas Street, Rockford, Ill.; Original application June 20, 1962; Serial Number 203,948; Divided and this application January 15, 1964; Serial Number 337,890; 5 Claims; (Cl. 42–62).

3,177,603; BARREL LOCK AND FEED RAMP DEVICE; Robert A. Gillespie, Cobourg, Ontario, Canada; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed March 20, 1964; Serial Number 353,552; 3 Claims; (Cl. 42–75).

3,177,771; COUNTER-RECOIL MECHANISM FOR FIREARMS; Carrol D. McKim, 791 34th Avenue.; San Francisco, Calif.; Filed Dec. 3, 1963; Serial Number 327,628; 7 Claims; (Cl. 89–14).

3,177,772; RAPID FIRE GUN; Arthur J. Stanton, Bethesda, Md.; and Philias H. Girouard, Pasadena, Calif.; assignors to the United States of America as represented by the Secretary of the Navy; Filed June 3, 1957; Serial Number 663,319; 14 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

April 20, 1965

3,178,845; RIFLE; Leroy J. Sullivan, 14542 Cork Street, Garden Grove, California; Filed April 29, 1963; Serial Number 276,383; 15 Claims; (Cl. 42–17).

3,179,011; GUN STABILIZER AND FLASH SUPPRESSION MEANS; Joseph L. Rahm, 1318 Perry Street NE., Washington, D.C.; Filed August 8, 1963; Serial Number 300,943; 11 Claims; (Cl. 89–14).

April 27, 1965

3,180,046; MAGAZINE FOR AUTOMATIC FIREARMS; Hartmut Menneking and Hermann Henning, Dusseldorf, Germany; assignors to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Field March 28, 1963; Serial Number March 30, 1962; R 32,388; 6 Claims. (Cl. 42–50).

3,180,226; REPLACEABLE GAS SYSTEM FOR FIREARMS; John L. Lockhead, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 3, 1964; Serial Number 342,318; 2 Claims; (Cl. 89–191). (Granted under Title 35, U.S. Code (1952), sec. 266).

May 4, 1965

3,181,262; EXTENSION FOR SHOTGUN BARREL; Edward W. Bridge, Sr., 1507 Foulkrod St., Philadelphia, Pa.; Filed December 1, 1964; Serial Number 415,012; 10 Claims; (Cl. 42–79).

3,181,423; MOTOR DRIVEN AUTOMATIC GUN; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 17, 1961; Serial Number 90,147; 7 Claims; (Cl. 89–161). (Granted under Title 35, U.S. Code (1952), sec. 266).

May 11, 1965

3,182,416; **SIGHTING SYSTEMS FOR RIFLE GRENADES**; Giulio Wyser, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed August 3, 1961; Serial Number 132,259; Claims priority application Luxembourg; September 16, 1960; 39,184; 2 Claims. (Cl. 42–1).

3,182,417; **PISTOL LOADING CLIP**; Lyman L. Hamilton, 401 Holly Ave.; South San Francisco, Calif.; Filed April 30, 1962; Serial Number 191,036; 6 Claims; (Cl. 42–89).

3,182,555; **FEED MECHANISM FOR EXTERNALLY POWERED AUTOMATIC GUN**; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 13, 1961; Serial Number 116.884; 9 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,182,556; **DISINTEGRATING CARTRIDGE BELT LINK AND CONNECTOR THEREFOR**; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of hte Army; Filed July 5, 1961; Serial Number 124,290; 7 Claims; (Cl. 89–35). (Granted under Title 35, U.S. Code (1952), sec. 266).

May 18, 1965

3,183,615; **SLIDE BARREL LEVER ACTION RIFLE AND THE LIKE**; Richard V. Hirsch, 839 E. 4500 South, Ogden, Utah; Filed November 8, 1963; Serial Number 322,359; 7 Claims; (Cl. 42–11).

3,183,616; **SELECTIVE ONE AND TWO-STATE TRIGGER MECHANISM FOR FIREARMS**; Warren L. Gandy, St. Petersburg, Fla.; assignor to the United States of America as represented by the Secretary of the Army; Filed October 6, 1964; Serial Number 402,040; 8 Claims; (Cl. 42–60). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,183,617; **GUN BARREL MOUNTING**; William B. Ruger and Harry H. Sefried II, Southport, Conn.; assignors to Sturn, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Filed March 30, 1964; Serial Number 355,545; 7 Claims; (Cl. 42–75).

3,183,618; **RECOIL AND STABILIZING MECHANISM FOR A RIFLE**; Lloyd J. Flewellen, 1427 E. Sandalwood, San Antonio, Texas; Filed June 11, 1964; Serial Number 374,465; 3 Claims; (Cl. 42–75).

3,183,778; **CARTRIDGE SUPPLY DEVICE**; Rudolf Stadelmann, Zurich, Switzerland; assignor to Verwaltungsgesellschaft der Werkzeugmaschinenfabrik Oerlikon, Zurich-Oerlikon, Switzerland; Filed November 5, 1963; Serial Number 321,631; Claims priority, applkcation Switzerland, November 9, 1952; 13,164/62). 2 Claims; (Cl. 89–33).

May 25, 1965

3,184,875; **FIRING CONTROL DEVICE FOR THE TRIGGER MECHANISM OF REPEATING SHOTGUNS**; Erich O. Klebe, Rte. 1, Zimmerman, Minn.; Filed May 14, 1964; Serial Number 367,345; 3 Claims; (Cl. 42–69).

3,184,876; **FIRING PIN SAFETY MECHANISM FOR FIREARMS**; Fritz Walther, Wetterstenweg 4, Ulm (Danube), Germany; Filed March 15, 1962; Serial Number 179,948; Claims priority application Germany, March 18, 1961; W 29,674; 6 Claims; (Cl. 42–70).

3,184,877; **PISTOL STABILIZER**; William G. Andrews, 504 Athania Parkway, Metairie, La.; Filed May 28, 1964; Serial Number 371,008; 4 Claims; (Cl. 42–72).

June 1, 1965

3,186,304; **HYPERVELOCITY GUN**; Arthur T. Biehl, Diablo, California; assignor to MB Associates, a corporation of California; Field October 22, 1962; Serial Number 232,314; 3 Claims; (Cl. 89–7).

3,186,305; **HYDRAULIC ACTUATOR MECHANISM**; John D. Lorimer, Birmingham, Michigan; assginor to Ex-Cell-O Corporation; Detroit, Michigan; Filed July 2, 1963; Serial Number 294,792; 2 Claims; (Cl. 89–37).

June 8, 1965

3,187,454; **REVOLVER CYLINDER STOP**; Eugene E. Geber, 1908 Douglas St., Rockford, Ill.; Original application June 20, 1962; Serial Number 203,948; Divided and this application January 15, 1964; Serial Number 337,891; 10 Claims; (Cl. 42–67).

3,187,455; **RIFLED GUN BARREL WITH PERMANENT PLASTIC DEFORMATION SURROUNDING THE FILLETS**; Tadeusz W. Wlodek, 297 5th Avenue, Ottawa, Ontario, Canada; Filed August 24, 1959; Serial Number 835,559; 3 Claims; (Cl. 42–78).

3,187,632; **PROJECTILE DISPERSION DEVICE FOR FIREARMS**; Earle M. Harvey, Agawam, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Field August 21, 1957; Serial Number 679,804; 1 Claim; (Cl. 89–14). (Granted under Title 35,U. S. Code 1952), sec. 266).

3,187,633; **CONTRA-JET MUZZLE BRAKE FOR FIREARMS**; David S. Tanabe, 7920 49th Ave. S., Seattle, Washington; Filed November 12, 1963; Serial Number 322,661; 5 Claims; (Cl. 89–14).

June 15, 1965

- 3,188,763; **BOLT ACTION PISTOL**; Roy C. Duncan, 522 Leeson Avenue, Cadillac, Michigan; Filed June 10, 1963; Serial Number 286,768; 6 Claims; (Cl. 42–16).
- 3,188,764; **TRIGGER PULL CONTROL FOR DOUBLE ACTION FIREARMS**; Oscar E. Harding, Blue River, Oregon; (P.O. Box 1094; Springfield, Oregon); Filed March 7, 1963; Serial Number 263,517; 11 Claims; (Cl. 42–69).
- 3,188,914; **EXPLOSIVE RELEASE IGNITION ASSEMBLY**; Walter L. Dahl, Greenfields Village, Woodbury, N.J.; assignor to E.I. du Pont de Nemours and Company, Wilmington, Del.; a corporation of Delaware; Filed August 30, 1963; Serial Number 305,633; 6 Claims; (Cl. 89–1).

June 22, 1965

- 3,190,023; **MULTIMAGAZINE TWO-STATE FEEDING DEVICE FOR FIREARMS**; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 24, 1963; Serial Number 283,116; 6 Claims; (Cl. 42–18).
- 3,190,179; **DISCONNECTABLE CARTRIDGE BELT LINK**; Paul H. Benoit, Chicopee Falls, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 8, 1964; Serial Number 366,199; 4 Claims; (Cl. 89–35). (Granted under Title 35, U.S. Code (1952), sec. 266).

June 29, 1965

- 3,191,330; **VIBRATION DAMPER FOR FIREARMS**; Ole N. Olson, 2909 Quentin, Minneapolis, Minn.; Filed June 29, 1964; Serial Number 378,669; 3 Claims; (Cl. 42–1).
- 3,191,331; **RIFLE BOLT AND SLEEVE FOR A RECEIVER HAVING AN OVAL BORE**; Gerald I. Hurley, c/o Groves, Dufford, Nelson & Spiecker, P.O. Box 1598, Grand Junction, Colorado; Filed October 25, 1962; Serial Number 233,017; 3 Claims; (Cl. 42–16).
- 3,191,332; **FIREARM MAGAZINE**; Edward J. Ardolino, 6 Whiting Farms Road, Branford, Conn.; Filed May 29, 1963; Serial Number 284,205; 5 Claims; (Cl. 42–50).
- 3,191,333; **CARTRIDGE REVOLVER SAFETY DEVICE**; Alexander Koltun, 2368 Hollyridge Drive, Los Angeles 28, Calif.; Continuation of application Serial Number 140,395; September 25, 1961. This application February 18, 1964; Serial Number 346,586; 4 Claims; (Cl. 42–59).
- 3,191,334; **GUN SPRING FIRE-CONTROL MECHANISM**; Jay P. Jarvis and Edwin S. Vartanian, New Haven, Conn.; assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed January 27, 1964; Serial Number 340,332; 8 Claims; (Cl. 42–69).

July 13, 1965

- 3,193,959; **SAFETY CHAMBER PLUG FOR FIREARMS**; William E. Jaycox, Bel Air, Md.; assignor to Henry Packard White, doing business as H.P. White Laboratory, Bel Air, Md.; Filed Mar. 26, 1963; Serial Number 268,002; 9 Claims; (Cl. 42–1).
- 3,193,960; **POCKET PISTOL**; Frederick F. Stevens, Jr.; Lane's Pond Road, Northford, Conn.; Filed June 7, 1963; Serial Number 286,254; 10 Claims; (Cl. 42–8).
- 3,193,961; **SINGLE TRIGGER MECHANISM**; Domenico Linarello, Brooklyn, N.Y.; assignor to Abercrombie & Fitch Company, New York, N.Y.; a corporation of New York; Filed December 27, 1963; Serial Number 333,993; 1 Claim; (Cl. 42–42).
- 3,194,118; **RECOILLESS GUN FOR SIMULTANEOUSLY SEPARATELY LOADING PROPELLANT AND PROJECTILE**; C. Walton Musser, Palos Verdes Estates, Calif.; and Robert W. Markgraf, Roslyn, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed January 28, 1963; Serial Number 254,513; 4 Claims; (Cl. 89–1.7). (Granted under Title 35, U.S. Code (1952), sec. 266).

July 20, 1965

- 3,195,259; **TRIGGER GUARD SAFETY FOR DUAL TRIGGER FIREARMS**; Robert Meunier, New Bedford, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 15, 1965; Serial Number 432,907; 5 Claims; (Cl. 42–70). (Granted under Title 35, U.S. Code (1952), sec. 266).
- 3,195,407; **LIQUID PROPELLANT PROJECTILE UNIT**; Charles F. Turner, Mount Carmel, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Original application May 7, 1963; Serial Number 278,676; Divided and this application October 19, 1964; Serial Number 411,663; 3 Claims; (Cl. 89–7).
- 3,195,408; **FIREARM CONSTRUCTION**; Nicholas P. Sherman, Sea Cliff, N.Y.; assignor to twenty percent to Albert C. Nolte, Jr.; New York, N.Y.; Filed November 2, 1962; Serial Number 235,605; 6 Claims; (Cl. 89–195).

July 27, 1965

3,196,568; **SWITCHING DEVICE FOR A TANDEM-TYPE MAGAZINE FEEDING SYSTEM**; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed January 7, 1964; Serial Number 336,327; 6 Claims; (Cl. 42–18). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,196,569; **SHOTGUN GAUGE ADAPTER**; Daniel J. Thomason, 156 Windemere St., Springfield, Mass.; Filed June 22, 1964; Serial Number 376,758; 1 Claim; (Cl. 42–77).

3,196,747; **DISCONNECTOR TRIGGER MECHANISM**; Ernest W. Gallagher and Robert A. Gillespie, both of Cobourg, Ontario, Canada; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed March 20, 1964; Serial Number 353,484; 2 Claims; (Cl. 89–145).

August 3, 1965

3,197,906; **FIRING MECHANISM INCLUDING A UNITARY SPRING WITH THREE ARMS**; Louis Elkas, Agawam, and Thomas J. Davies, Springfield, Mass.; assignors to Emhart Corporation; a corporation of Connecticut; Filed September 19, 1963; Serial Number 309,991; 5 Claims; (Cl. 42–69).

3,197,907; **REVOLVER CARTRIDGE CLIP**; Ole N. Olson, Minneapolis, Minn.; assignor by direct and mesne assignments of 33.93% to James J. Salinas, 33.93% to Arthur J. Pasmas, 17.86% to Central Indiana Real Estate and Development Corporation, 7.14% to Johnston Container Corporation, and 7.14% to Harlan B. Livengood; Filed September 26, 1963; Serial Number 311,877; 1 Claim. (Cl. 42–89).

3,198,074; **PIEZOELECTRIC-POWERED GUN FIRING MECHANISM**; William E. Perkins, Runnemede, N.J.; assignor to the United States of America as represented by the Secretary of the Army; Filed April 30, 1964; Serial Number 364,046; 6 Claims; (Cl. 89–12). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,198,075; **AUTOMATIC FIREARM WITH A RECOILING BARREL**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A.; Geneva, Switzerland; a society of Switzerland; Filed May 28, 1962; Serial Number 198,195; Claims priority application Luxembourg, June 2, 1962, 40,215; June 21, 1961, 30,296; 6 Claims. (Cl. 89–33).

3,198,076; **CONVERTIBLE GUN**; Eugene M. Stoner, Newport Beach, Calif.; assignor of one-half to Rhoda Jeanne Stoner, Malibu, Calif.; Filed March 22, 1963; Serial Number 267,183; 15 Claims. (Cl. 89–128).

3,198,077; **ACTION FOR AUTOMATIC FIREARMS AND MACHINE GUNS**; Ross A. Close, 3831 Glenbrook Road, Fairfax County, Va.; Filed March 23, 1964; Serial Number 353,783; 1 Claim. (Cl. 89–174).

August 10, 1965

3,199,240; **SAFETY FOR GUNS**; William M. Largen, 1938 Avon Road, Roanoke, Va.; Filed June 17, 1963; Serial Number 288,326; 6 Claims; (Cl. 42–70).

3,199,407; **BOLT FOR AUTOMATIC WEAPON**; Raymond C. Henisa, New York, N.Y.; (R.R. 3, Columbia City, Ind.); Filed May 22, 1964; Serial Number 370,324; 4 Claims; (Cl. 89–187).

August 17, 1965

3,200,528; **DEVICE FOR SUPPORTING A PISTOL ON A BELT**; Harold C. Christensen, Pine Hill Road, Croton-on-Hudson, N.Y.; Filed December 10, 1963; Serial Number 329,553; 5 Claims; (Cl. 42–94).

3,200,709; **FIRING MECHANISM WITH INTEGRAL SAFETY**; Alfred L. Montana, East Longmeadow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 17, 1964; Serial Number 345,537; 5 Claims; (Cl. 89–142). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,200,710; **GAS OPERATING MECHANISM FOR AUTO-LOADING FIREARM**; Robert P. Kelly and Wayne E. Leek, Ilion, James S. Martin, Mohawk, Charles H. Morse, Herkimer, Clark B. Workman, Ilion, and John A. Roberts, Utica, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed December 27, 1963; Serial Number 333,889; 7 Claims; (Cl. 89–191).

August 24, 1965

3,201,886; **MAGAZINE INTERCEPTOR LATCH**; Robert P. Kelly and Wayne E. Leek, Ilion, James S. Martin, Mohawk, Charles H. Morse and Richard E. Nightingale, Herkimer, and John A. Roberts, Utica, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed December 27, 1963; Serial Number 333,878; 8 Claims. (Cl. 42–17).

3,201,887; **FOLDING STOCK FOR SHOULDER ARMS**; Herve L. Sedelow, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed July 20, 1964; Serial Number 384,008; 5 Claims. (Cl. 42–72). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,202,055; **VALVE SYSTEM FOR COMPRESSION IGNITION DEVICE**; David F. Butler and Glen R. Dixon, Hamden, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed November 1, 1963; Serial Number 320,904; 5 Claims. (Cl. 89–7).

3,202,056; FIREARM MUZZLE BRAKE; Kurt Seeberger, Zurich, Switzerland; assignor to Verwaltungsgesellschaft der Werkzeugmaschinenfabrik Oerlikon, Zurich, Switzerland; March 4, 1963; 2,778/62); 2 Claims. (Cl. 89–14).

August 31, 1965

3,203,128; GUN HAMMER-SPRING MECHANISM; Harvey H. Friend, Hamden, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed February 3, 1964; Serial Number 342,189; 6 Claims. (Cl. 42–69).

3,203,129; BOLT ACTION RIFLE BARREL CONSTRUCTION; Louis Elkas, Agawam, Mass.; assignor to Emhart Corporation, a corporation of Connecticut; Filed November 19, 1963; Serial Number 324,670; 4 Claims. (Cl. 42–76).

3,203,120; REVOLVER CARTRIDGE CLIP WITH A SERIES OF IRREGULAR STEPS ON ONE FACE; Gabriel Alfonso y Diaz, Mahatma Ghanda 19, Santo Domingo, Dominican Republic; Filed May 1, 1964; Serial Number 364,224; 5 Claims. (Cl. 42–89).

3,203,312; DEVICE FOR DELAYING THE ARMING OF COMBINATION AUTOMATIC AND SEMI-AUTOMATIC FIREARMS; Pier Giuseppe Beretta, Gardone, Val Trompia (Brescia), Italy; assignor to Fabbrica d'Armi P. Beretta S.p.A.; Gardone, Val Trompia (Brescia), Italy; a company of Italy; Filed December 9, 1963; Serial Number 328,857; Claims priority; application Italy, December 13, 1962; 24,352/62; 2 Claims; (Cl. 89–129).

September 7, 1965

3,204,361; LARGE CAPACITY MAGAZINE FOR FIREARMS; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 3, 1964; Serial Number 342,317; 2 Claims. (Cl. 42–50). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,204,527; APPARATUS AND METHOD FOR PRODUCING VERY HIGH VELOCITIES; Charles S. Godfrey, Berkeley, and Franklin C. Ford, Pleasanton, Calif.; assignors by mesne assignments to Physics International Company, Berkeley, Calif.; a corporation of California; Filed August 20, 1962; Serial Number 218,008; 18 Claims. (Cl. 89–8).

3,204,528; INTERMITTENT FEED MECHANISM FOR HIGH-INERTIAL LOAD; Kenneth J.H. McGowan, Richmond, Ind.; assignor to Avco Corporation, Richmond, Indiana; a corporation of Delaware; Filed September 30, 1963; Serial Number 312,670; 19 Claims; (Cl. 89--33).

3,204,529; CONTROLLED BURST FIRING MECHANISM; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 4, 1964; Serial Number 364,868; 7 Claims; (Cl. 89–140). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,204,530; ROCKET BOOSTED AUTOMATIC WEAPON AND AMMUNITION SYSTEM; Kenneth J.J.McGowan, Richmond, Ind.; assignor to Avco Corporation, Richmond, Ind.; a corporation of Delaware; Filed October 15, 1963; Serial Number 316,224; 47 Claims; (Cl. 89–183).

3,204,531; FIREARM DRIVE SPRING DEVICE; Henry P. Swieskowski, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 4, 1964; Serial Number 349,508; 3 Claims; (Cl. 89–199). (Granted under Title 35, U.S. Code (1952), sec. 266).

September 14, 1965

3,205,604; CO2 ACTUATED CARTRIDGE MAGAZINE; Roy D. Plummer, Santa Barbara, Calif.; assignor to General Motors Corporation, Detroit, Michigan; a corporation of Delaware; Filed December 4, 1962; Serial Number 242,181; 4 Claims. (Cl. 42–50).

September 21, 1965

3,206,884; ADJUSTABLE TRIGGER SHOE; Vinson C. Purvis, P.O. Box 6792, Stanton, California; Filed April 10, 1964; Serial Number 358,826; 7 Claims. (Cl. 42–69).

3,206,885; FIREARM WITH METAL BEARING MEMBER AND PLASTIC MATERIAL BETWEEN RECEIVER AND STOCK; Garnet Jethro Dye, 950 Veltre Circle, SW., Atlanta, Ga.; Filed October 1, 1963; Serial Number 312,907; 4 Claims; (Cl. 42–75).

3,207,036; COMBINATION INTERNAL RETAINING RING, ADJUSTABLE POSITIONER AND SWIVEL BEARING FOR GUNS; Leo F. Norton, Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Continuation of application Serial Number 268,503; March 27, 1963. This application November 12, 1964, Serial Number 416,177; 4 Claims. (Cl. 89–191). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,207,037; PISTOL BARREL MOUNTING STRUCTURE; Frank A. Pachmayr, Culver City, and George Hoenig, La Mirada, California; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed January 20, 1964; Serial Number 338,929; 26 Claims. (Cl. 89–196).

September 28, 1965

3,208,176; SAFETY DEVICE FOR GUNS; John E. Giles, Rte. 1, Box 41A, Odessa, Fla.; Filed June 10, 1964; Serial Number 374,051; 10 Claims; (Cl. 42–66).

3,208,177; SAFETY LOCKING DEVICE FOR PUMP TYPE MAGAZINE FIREARMS; Bruce E. Barr, 496 Monreith St., Winnipeg, Manitoba, Canada; Filed October 19, 1964; Serial Number 404,659; 14 Claims; (Cl. 42–70).

3,208,178; LOCKING DEVICE FOR FIREARM STOCKS; Abe Seiderman, Coral Gables, Fla.; assignor to Universal Firearms Corporation, Hialeah, Fla.; a corporation of Florida; Filed September 24, 1964; Serial Number 398,859; 3 Claims. (Cl. 42–71).

3,208,179; SPRING TYPE SHOCK ABSORBER FOR FIREARMS; James Hrebicek, 2327 61st Ave., Cicero, Ill.; Filed March 25, 1963; Serial Number 267,535; 14 Claims; (Cl. 42–74).

3,208,180; RECOIL PAD FOR GUN STOCKS; Fletcher H. Woodcock, Ithaca, N.Y.; assignor to Ithaca Gun Company, Incorporated, Itahca, N.Y.; a corporation of New York; Filed February 12, 1965; Serial Number 432,305; 1 Claim. (Cl. 42–74).

3,208,181; ELECTRICALLY CONTROLLED FIREARM UTILIZING A PIEZO-ELECTRIC CRYSTAL; John D. Calhoun, Stratford, and Franklin B. Clay, Jr.; Westport, Conn.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed November 26, 1963; Serial Number 325,846; 12 Claims; (Cl. 42–84).

3,298,345; ANTI-SPIN DEVICE; Emil W. Thompson, Succasunna, N.J.; assignor to the United States of America as represented by the Secretary of the Army; Filed January 29, 1964; Serial Number 341,137; 3 Claims. (Cl. 89–1).

3,208,348; GUN MUZZLE ATTACHMENT DEVICE FOR COUNTERACTING RECOIL; Clarence H. Lee, 4725 W. 160th St., Lawndale, Calif.; Filed October 12, 1964; Serial Number 403,279; 12 Claims. (Cl. 89–14).

3,208,350; MULTI-BARRELED PROJECTOR AND BLOCK AMMUNITION; Russell S. Robinson, 124 Via Yella, Newport Beach, Calif.; Filed July 30, 1962; Serial Number 213,180; 3 Claims. (Cl. 89–34).

3,208,351; MICROMETER REST FOR FIELD GUN; Sol Dubin, Rockville Centre, N.Y.; (217 Merrick Road, Amityville, N.Y.); Filed February 18, 1964; Serial Number 345,734; 6 Claims; (Cl. 89–40).

October 5, 1965

3,209,480; FIRING PIN SAFETY DEVICE FOR A PISTOL; Glen L. Mittelsteadt, Waseca, Minn.; assignor to Herter's Inc.; Waseca, Minn.; a corporation of Minnesota; Filed August 28, 1964; Serial Number 392,829; 5 Claims. (Cl. 42–70).

3,209,481; GUNSTOCK WITH AN ARCUATE ARM ENGAGING END PORTION; William V.T. Gilbert, 3165 Ferndale, Las Vegas, Nevada; Filed March 23, 1964; Serial Number 353,968; 6 Claims; (Cl. 42–71).

3,209,482; RECOIL DEVICE FOR A SHOULDER FIREARM; John J. Kuzma, North Haven, and Kieran D. Doyle, Wallingford, Conn.; assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed October 20, 1964; Serial Number 405,220; 7 Claims; (Cl. 42–74).

October 12, 1965

3,210,878; SEMI-AUTOMATIC MISSILE LAUNCHER; Albert L. Cleaver, Roy F. Range, and Kenneth J.J. McGowan, Richmond, Indiana; assignors to Avco Corporation, Richmong, Indiana; a corporation of Delaware; Filed April 2, 1964; Serial Number 356,808; 37 Claims; (Cl. 42–17).

3,210,879; FIRING BUTTON FOR GUN; Earl P. La Rue, Box 306, Jerome, Michigan; Filed September 23, 1964; Serial Number 398,695; 1 Claim. (Cl. 42–69).

3,211,058; ROUND RAMMER; Paul H. Dixon and Maynard D. Wallin, Rockford, Ill.; assignors to the United States of America as represented by the Secretary of the Army; Filed April 18, 1960; Serial Number 156,574; 6 Claims. (Cl. 89–33).

October 19, 1965

3,212,208; AUGMENTOR AND SABOT STRIPPER FOR HYPERVELOCITY LIGHT GAS GUN; Mario A. Persechino, Temple Hills, Md.; and Harold V. Schlemmer, Washington, D.C.; assignors to the United States of America as represented by the Secretary of the Navy; Filed September 25, 1964; Serial Number 399,424; 4 Claims; (Cl. 42–76). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,212,402; HAND WEAPON; Mathew C. Hengel, Hayward, and Arthur T. Biehl and Robert Mainhardt, Diablo, Calif.; assignors to MB Associates; a corporation of California; Filed November 29, 1962; Serial Number 240,784; 6 Claims; (Cl. 89–1.7).

October 26, 1965

3,213,558; MEANS FOR MOUNTING BOLT-ACTUATING DEVICE FOR FIREARMS; Ole Horsrud, deceased, late of Fox River Grove, Ill., by Helen H. Asker; executrix, Crystal Lake, Ill.; assignor to The High Standard Manufacturing Corporation, Hamden, Conn.; a corporation of Connecticut; Filed March 4, 1964; Serial Number 350,631; 3 Claims; (Cl. 42–17).

3,213,559; **LOADING DEVICE FOR REVOLVERS**; Donald Matich, 6148 Monterey Road, Los Angeles, Calif.; Filed April 27, 1964; Serial Number 362,736; 4 Claims. (Cl. 42–89).

3,215,041; **STRAIN LOCKED NOZZLE FOR RECOILLESS WEAPONS**; Francis W. Dietsch, Levittown, and Andrew J. Grandy, North Hills, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed April 30, 1964; Serial Number 364,041; 5 Claims. (Cl. 89–1.7). (Granted under Title 35, U.S. Code (1952), sec. 266).

November 9, 1965

3,216,323; **PROPELLANT CHARGE WITH REARWARDLY ATTACHED TAMPING BODY FOR NONRECOILING WEAPONS**; Karl Wengenroth, Munich, and Wilhelm Perniss, Nurnberg, Gernamy; assignors to Diehl, Nurnberg, Germany; Filed July 29, 1963; Serial Number 298,385; Claims priority, application Germany; August 1, 1962; W 32,717; August 11, 1962, D 39,605; Dec. 20, 1962, D 40.556; 11 Claims; (Cl. 89–1.7).

November 16, 1965

3,217,441; **PRACTICE FIREARM**; Raymond William Kerr, Box 4178, Lincoln, Nebraska; Filed May 7, 1964; Serial Number 365,701; 4 Claims; (Cl. 42--77).

3,217,600; **AMMUNITION BOXES FOR HOUSING FAN-LIKE ASSEMBLIES OF CARTRIDGES**; Peter Stubbe, Viotho (weser), Germany; assignor to Friedrich Stubbe, Vlotho (Weser), Germany; Filed March 3, 1964; Serial Number 349,105; Claims priority, application Germany, December 16, 1963; St 21,470; 6 Claims; (Cl. 89–34).

3,217,601; **GUN FIRING CONTROL DEVICE**; Davis L. Gardner, Fort Walton Beach, Florida; assingor to the United States of America as represented by the Secretary of the Air Force; Filed May 26, 1964; Serial Number 370,214; 3 Claims; (Cl. 89–135).

November 23, 1965

3,218,927; **HATCH REMOVER**; Albert M. Stott, Southampton, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed October 1, 1963; Serial Number 313,131; 4 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 255).

3,218,930; **GUN MOUNT WITH AMMUNITION SUPPLYING MEANS**; Philias H. Girouard, Washington, D.C., Carl V. Hickman, deceased, late of Kensington, Md., by Jean W. Hickman, administratrix, Washington, D.C., Garold A. Kane, John I. Nelson, Milton C. Neuman, and Harrison Randolph, Minneapolis, Minn, and Thomas C. Colleri, Washington, D.C.; assignors by direct and mesne assginments, to the United States of America as represented by the Secretary of the Navy; Filed Augusy 27, 1952; Serial Number 306,612. 74 Claims. (Cl. 89–45).

November 30, 1965

3,220,135; **SAFETY MECHANISM AGAINST PREMATURE FIRING OF GUNS**; Isaac Irusta, Elbar, Guipuzcoa, Spain; assignor to Star, Bonifacio Echeverria, S.A., Elbar, Guipuzcoa, Spain; a corporation of Spain; Filed August 5, 1964; Serial Number 387,671; Claims priority, application Spain, August 9, 1963; 290,718; 4 Claims. (Cl. 42–70).

3,220,310; **BREECH CLOSURE FOR FIREARMS**; Josef Eder, Dachau, Germany, assignor to Erma-Werke Waffen- und Maschinenfabrik G.m.b.H.; Dachau, Germany; a corporation of Germany; Filed April 28, 1964; Serial Number 363,081; Claims priority, application Germany, November 19, 1963; E 25,885; 3 Claims. (Cl. 89–189).

December 7, 1965

3,221,603; **CARTRIDGE FEEDING MECHANISM FOR FIXED-BARREL, SLIDE-OPERATED GUNS**; John L. Lockhead, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 23, 1964; Serial Number 354,183; 7 Claims; (Cl. 89–33). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,221,604; **BOLT ACTION FIREARM WITH CHARGER**; Walter H.B. Smith, deceased, late of New York, N.Y.; by Katherine B. Groves, executrix, late of 150 W. 58th st., New York, N.Y.; Alice Denhoff, substitude executrix of said Katherine B. Groves, deceased; Original applications April 5, 1956; Serial Number 576,275; now Patent Number 2,894,346; dated July 14, 1959, and October 15, 1958, Serial Number 767,358; now Patent No. 3,090,148; dated May 21, 1963; Divided and this application October 23, 1962; Serial Nubmer 232,619; 1 Claim; (Cl. 89–187).

December 14, 1965

3,222,808; **SHOTGUN FRAME AND BLOCK ASSEMBLY**; Walter H. B. Smith, deceased, late of New York, N.Y., by Katherine B. Groves, execitrix, New York, N.Y.; Alice Denhoff, substitute executrix of sail Walter H. B. Smith, deceased; Original application December 2, 1959; Serial Number 856,751, now Patent No. 3,077,045, dated February 12, 1963; Divided and this application May 11, 1962; Serial Number 199,553; 2 Claims; (Cl. 42–44).

3,222,809; **AUTOMATIC SAFETIES FOR GUNS**; Harvard J. Bryan, 9303 Sorrento, Dallas, Texas; Filed June 8, 1964; Serial Number 373,388; 17 Claims; (Cl. 42–70).

3,222,810; **MAGAZINE LOADING CLIP**; Daniel D. Musgrave, 8201 Caraway Street, Cabin John, Md.; Filed June 23, 1964; Serial Number 377,250; 2 Claims; (Cl. 42–87).

3,222,989; **REVOLVER-TYPE GUN WITH BOLT**; Ewald A. Kamp, Chicago, Ill.; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed March 25, 1960; Serial Number 17,717; 7 Claims; (Cl. 89–155).

December 21, 1965

3,224,337; **HYPERVOLICY GUN**; Franklin C. Ford and Arthur T. Biehl, Walnut Creek, Calif.; assignors to MB Associates; a corporation of California; Filed June 7, 1962; Serial Number 200,700; 3 Claims. (Cl. 89–8).

December 28, 1965

3,225,481; **GUN WITH PROTECTIVE GUARD FOR FOREARM EXTENSION**; James H. Shoulders, Cohawkin Road, R.F.D. 1, Paulsboro, N.J.; Filed April 7, 1965; Serial Number 446,253; 7 Claims. (Cl. 42–71).

3,225,482; **CARTRIDGE LOADING CLIP FOR REVOLVERS**; Ole N. Olson, 2909 Quentin Ave. S., Minneapolis, Minn.; Filed November 10, 1964; Serial Number 410,159; 5 Claims. (Cl. 42–89).

3,225,653; **CHARGING HANDLE ASSEMBLY**; Charles F. Packard, East Longmeadow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 5, 1964; Serial Number 365,218; 6 Claims; (Cl. 89–1). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,225,656; **FIELD RIFLE REST**; John T. Flaherty, 246 S. Lexington Avenue, White Plains, N.Y.; and Richard R. Scholz, 22 N. French Ave., Elmsford, N.Y.; Filed September 14, 1964; Serial Number 396,142; 5 Claims; (Cl. 89–37).

3,225,657; **CLOSED BREECH GUN**; George R. Kruzell, 4301 Hotchkiss, Bay City, Michigan; Filed July 15, 1964; Serial Number 382,864; 9 Claims. (Cl. 89–187).

January 4, 1966

- 3,226,868; **PIVOTABLE TELESCOPE SIGHT MOUNT**; Woodrow L. Mahoney, 10129 NE Saratoga St., Portland, Oregon; Filed October 22, 1962; Serial Number 232,097; 2 Claims. (Cl. 42—1).
- 3,226,869; **MULTIPLE ROW CARTRIDGE MAGAZINE**; Daniel D. Musgrave, 8201 Caraway St., Cabin John, Md.; Filed November 23, 1964; Serial Number 412,980; 5 Claims; (Cl. 42—50).
- 3,226,870; **HANDGUN HAMMER ENCLOSING HANDGRIPS**; Leon Labble and Allen M. Bernkrant, both of Box 456, Miami 35, Florida; Filed August 3, 1964; Serial Number 387,146; 6 Claims; (Cl. 42—71).
- 3,226,871; **SHOTGUN MUZZLE CONSTRUCTION**; Ralph G. Sargent, 408 W. Windsor St., Lakeland, Florida, and Roy F. Albritton, 1130 Garden St., Bartow, Florida; Filed October 8, 1964; Serial Number 402,546; 4 Claims; (Cl. 42—79).
- 3,226,872; **GUN SLING SWIVEL**; Frank A. Pachmayr, 4215 Ince Blvd., Culver City, Calif.; Filed May 25, 1964; Serial Number 369,943; 2 Claims; (Cl. 42—85).
- 3,227,045; **CLOSED BREECH ROCKET GUN**; George R. Kruzell, 4301 Hotchkiss, Bay City, Michigan; Filed July 15, 1964; Serial Number 382,863; 9 Claims; (Cl. 89—187).
- 3,227,046; **AUTOMATIC PISTOL**; Tilo Wolfram Moller, Oberndorf (Neckar), Germany; assignor to Messrs. Heckler and Koch G.m.b.H.; Oberndorf (Neckar), Germany; Filed May 14, 1964; Serial Number 367,469; Claims priority, application Germany, May 20, 1963; H 49,225; 5 Claims; (Cl. 89—196).

January 11, 1966

- 3,228,298; **RIFLE BARREL**; Andrew J. Grandy, 2707 Grant Avenue, North Hills, Pa., and John J. Donnelly, Jr., 3 Laurel Lane, Levittown, Pa.; Filed April 20, 1960; Serial Number 23,582; 5 Claims. (Cl. 89—16). (Granted under Title 35, U.S. Code (1952), sec. 266).
- 3,228,299; **BIAS ADJUSTMENT FOR SPOTTING RIFLES**; Andrew J. Grandy, North Hills, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed November 18, 1963; Serial Number 324,590; 9 Claims. (Cl. 89—41). (Granted under Title 35, U.S. Code (1952), sec. 266).

January 18, 1966

- 3,229,399; **HANGFIRE INDICATOR FOR AUTOMATIC FIREARMS**; Earle M. Harvey, Agawam, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed October 26, 1964; Serial Number 406,624; 1 Claim. (Cl. 42—1). (Granted under Title 35, U.S. Code (1952), sec. 266).
- 3,229,400; **FIREARM**; Albert J. Del Pozo, Jr.; New York, N.Y.; (160-64 25th Drive, Whitestone, N.Y.); Filed June 25, 1964; Serial Number 377,837; 8 Claims. (Cl. 42—36).
- 3,229,401; **CHECKERED GUN STOCK**; Michael J. Sobran, Woodbridge, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed June 12, 1963; Serial Number 287,274; 2 Claims. (Cl. 42—71).
- 3,229,402; **VARIABLE-EFFECT SHOTGUN CHOKE**; Hugh P. Thacker, Azusa, Calif.; assignor to Horatio A. Warren, Azusa, Calif.; Filed Jan. 22, 1964; Serial Number 339.411; 6 Claims. (Cl. 42—79).
- 3,229,583; **GUN FLARED PROJECTILE**; Thomas J. Long and Joe C. McCaslin, Charlotte, N.C.; assignors to Douglas Aircraft Company, Inc.; Santa Monica, Calif.; Filed January 29, 1964; Serial Number 341,001; 9 Claims. (Cl. 89—14).
- 3,229,584; **AUTOMATIC FIREARM FEED MECHANISM**; Robert Zehnder, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed May 27, 1963; Serial Number 283,330; Claims priority, application Luxembourg, May 25, 1962; 41,779; 2 Claims. (Cl. 89—33).

January 25, 1966

- 3,230,654; **SIGHTING RIB FOR FIREARMS**; Robert Alexander Smith, 4288 Cypress St., Vancouver 9, British Columbia, Canada; Filed November 27, 1964; Serial Number 414,246; 9 Claims; (Cl. 42—76).
- 3,230,828; **BELT FEED MECHANISMS FOR AUTOMATIC FIREARMS**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Confederation of Switzerland, Geneva, Switzerland; Filed December 23, 1963; Serial Number 332,827; Claims priority, application Luxembourg, December 21, 1962; 42,912; 1 Claim. (Cl. 89—33).
- 3,230,829; **DRAWN GUN CARRIAGES**; Oscar Melliger, Zurich, Switzerland; assignor to Verwaltungsgesellschaft der Werkzeugmaschinenfabrik Oerlikon; Filed March 2, 1964; Serial Number 348,474; Claims priority, application Switzerland, March 5, 1963; 2,779/63). 5 Claims. (Cl. 89—40).

February 8, 1966

- 3,233,354; **HYDRAULIC RECOIL ABSORBER FOR SHOULDER-FIRED FIREARMS**; John M. Ahearn, 1920 SW 86th Ave., Miami, Fla.; Filed August 14, 1964; Serial Number 389,596; 3 Claims; (Cl. 42—74).
- 3,233,516; **GUN MOUNTS**; Robert Ramseyer, Versoix, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques SA., Geneva, Switzerland; Filed July 20, 1964; Serial Number 383,640; Claims priority, application Luxembourg, July 22, 1963; 44,107; 5 Claims. (Cl. 89—40).

3,233,517; TRIPODAL GUN SUPPORT; Robert N. Morrison, 1209 New St., Marshallton, Wilmington, Del.; Filed September 8, 1964; Serial Number 396,473; 9 Claims. (Cl. 89–40).

February 15, 1966

3,234,679; THUMB-OPERATED SAFETY FOR BOLT-ACTION FIREARMS; Carl H. Benson, New Haven, Conn.; assignor to O.F. Mossberg & Sons, Inc.; North Haven, Conn.; a corporation of Connecticut; Filed December 17, 1964; Serial Number 419,061; 4 Claims. (Cl. 42–70).

3,234,850; BREECH MECHANISMS FOR AUTOMATIC FIREARMS HAVING A RECOILING TUBE; Bernard Maillard, Geneva, Switzerland; assignor to Brevet Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed May 28, 1962; Serial Number 198,261; Claims priority, application Luxembourg, June 2, 1961; 40,215; June 21, 1961; 40,296; 1 Claim. (Cl. 89–176).

February 22, 1966

3,235,993; EJECTOR-EXTRACTOR MECHANISM FOR REPEATING AUXILIARY FIREARM OF PUMP ACTION TYPE; Robert F. Magardo, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 15, 1965; Serial Number 440,040; 8 Claims. (Cl. 42–25). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,235,994; DETACHABLE MAGAZINE; Louis S. Grippe, 138 Merritt Drive, Butler, Pa.; Filed July 28, 1964; Serial Number 385,711; 8 Claims; (Cl. 42–50).

3,235,995; CARTRIDGE RETAINING DEVICE FOR LIPLESS MAGAZINES; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed September 23, 1964; Serial Number 398,813; 3 Claims. (Cl. 42–50). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,235,996; FIREARM WITH A SLIDABLE, SLITTED JACKET IN THE CARTRIDGE CHAMBER HOUSING; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed May 1, 1963; Serial Number 277,346; Claims priority, application Luxembourg, Mat 24, 1962; 41,767; 3 Claims. (Cl. 42–76).

3,235,997; BIPOD GUN MOUNT; Eugene M. Stoner, Rte. 1, Box 70, Port Clinton, Ohio; Filed December 16, 1964, Serial Number 418,851; 8 Claims. (Cl. 42–94).

3,235,998; GUN REST; William T. Hadley, New York, N.Y.; assignor to Ten Ring Manufacturing Corporation; a corporation of New York; Filed January 4, 1965; Serial Number 423,048; 1 Claim. (Cl. 42–94).

3,236,153; HYDRAULIC DAMPING MECHANISM FOR A MOUNT; Fred N. Newcomb, Kingsville, Md.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 20, 1964; Serial Number 369,043; 7 Claims; (Cl. 89–37). (Granted under Title 35, U.S. Code (1952), sec. 266).

3,236,154; MECHANISM FOR REDUCING THE RATE OF FIRE IN AUTOMATIC FIRING ARMS; Kenzo Iwashita, Chikusa-ku, Nagoya-shi, Japan; assignor to Howa Kogyo Kaboushiki Kaisha, Nagoya-shi, Japan; a joint-stock company of Japan; Filed April 16, 1964; Serial Number 360,297; Claims priority, application Japan, June 8, 1963; 38/33,081; 3 Claims. (Cl. 89–128).

3,236,155; FIREARM HAVING AN AUXILIARY BOLT CLOSURE MECHANISM; Foster E. Sturtevant, West Hartford, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed July 8, 1964; Serial Number 381,099; 15 Claims; (Cl. 89–199).

March 1, 1966

3,237,335; SAFETY FIREARM AND AMMUNITION FOR THE SAME; Raymond William Kerr, Box 4178, Lincoln, Nebraska, 68507; Filed May 21, 1964; Serial Number 369,129; 8 Claims. (Cl. 42–8).

3,237,336; CYLINDER RATCHET MECHANISM FOR REVOLVER TYPE FIREARMS; Karl R. Lewis, Ogden, Utah; assignor to Browning Industries, Inc.; Ogden, Utah; as tenants in common; Filed May 31, 1963; Serial Number 284,444; 4 Claims. (Cl. 42–59).

3,237,522; AUTOMATIC FIREARM; James Gregory Neff, 4162 Sherel Lane, Cincinnati, Ohio; Filed August 7, 1964; Serial Number 388,053; 8 Claims. (Cl. 89–182).

March 8, 1966

3,238,657; SPECIAL GUN CHAMBER TO PREVENT PLASTIC BODY MOUTH CUT OFF; Donald S. Foote, Greens Farms, and Justin H. Whipple, Milford, Conn.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed June 1, 1964; Serial Number 371,305; 1 Claim. (Cl. 42–76).

3,238,844; GUIDING DEVICE FOR GUIDING SHELL CASINGS EJECTED BY THE RECOIL OF A GUN; Arent Gustav Carlsson, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed Nov. 17, 1964; Serial Number 411,742; Claims priority, application Sweden, November 21, 1963; 12,873/63; 4 Claims. (Cl. 89–45).

3,238,845; **CARTRIDGE HOISTING DEVICE FOR AN AUTOMATIC GUN**; Carl Mauritz Christiansson, Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed November 30, 1964; Serial Number 414,658; Claims priority, application Sweden, November 29, 1963; 13,242/63; 3 Claims; (Cl. 89–46).

March 15, 1966

3,239,959; **REMOVABLE MAGAZINE FOR REPEATING GUN**; Harry H. Sefried II, and Douglas S. McClenahan, Southport, Conn.; assignors to Sturm Ruger and Company, Inc., Southport, Conn.; a corporation of Connecticut; Filed March 24, 1964; Serial Number 354,328; 17 Claims. (Cl. 42–19).

3,240,121; **SELF-LOADING GUNS**; Harry H. Sefried II, Southport, Conn.; assignor to Sturm, Ruger and Company, Inc.; Southport, Conn.; a corporation of Connecticut; Filed August 31, 1964; Serial Number 393,309; 8 Claims. (Cl. 89–130).

3,240,122; **SELECTIVE FIRE CONTROL MECHANISM**; Seaman P. Bolles, 103 Tuttle Road, San Antonio, Texas; Filed April 14, 1964; Serial Number 359,596; 3 Claims. (Cl. 89–140).

March 22, 1966

3,241,445; **APPARATUS FOR FIRING GUNS**; Paul Zehfeld and Karl-Egon Janssen, Dusseldorf, Germany; assignors to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed December 8, 1964; Serial Number 416,759; Claims priority application Germany, December 12, 1963; R 36,773; 4 Claims; (Cl. 89–28).

3,241,446; **ARMOUR CUPOLA**; Hermann Wey, Wallisellen Zurich Switzerland; assignor to Verwaltungsgesellschaft der Werkzeugmaschinenfabrik Oerlikon, Zurich-Oerlikon, Switzerland, Filed May 4, 1964; Serial Number 364,732; Claims priority application Switzerland, May 16, 1963; 6,166/63; 4 Claims; (Cl. 89–36).

3,241,447; **CARTRIDGE RAMMING DEVICE OF A GUN**; Carl Mauritz Christiansson, Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed November 30, 1964; Serial Number 414,638; Claims priority application Sweden, November 28, 1963; 13,171/63; 3 Claims. (Cl. 89–47).

3,241,448; **CIRCUITOUS CAM TRACK WITH CROSSOVERS AND FOLLOWER DEVICE THEREFOR**; John G. Rocho, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed December 3, 1964; Serial Number 415,834; 8 Claims; (Cl. 89–161).

3,241,449; **BARREL BIASING MEANS FOR AUTOMATIC FIREARM**; Daniel I. Dwyer, Sr., 4167 Palmetto Way, San Diego, Calif.; Filed July 23, 1964; Serial Number 384,956; 10 Claims. (Cl. 89–196).

March 29, 1966

3,242,606; **ACTION-BAR CONNECTION FOR FIREARMS**; Paul A. La Violette, Jr., Hamden, Conn.; assignor to The High Standard Manufacturing Corporation, Hamden, Conn.; a corporation of Connecticut; Filed July 1, 1965; Serial Number 468,799; 4 Claims. (Cl. 42–17).

3,242,607; **FIREARM FIRING MECHANISM ESPECIALLY FOR REVOLVERS**; Roy J. Tappehorn, 2536 Kings Highway, Louisville, Ky.; Filed October 12, 1964; Serial Number 403,042; 58 Claims. (Cl. 42–65).

3,242,608; **FOREARM STABILIZER FOR SHOTGUN AND RIFLES**; Denxil Noble Heppard, 318 Illinois St., Vallejo, Calif.; Filed December 4, 1964; Serial Number 415,948; 3 Claims. (Cl. 42–71).

3,242,609; **CARTRIDGE CARRYING AND LOADING CLIP**; Arnold A. Koistinen, Rte. 1, Box 184; Madison, S. Dakota; Filed November 2, 1964; Serial Number 408,245; 5 Claims. (Cl. 42–87).

3,242,812; **SEMI-AUTOMATIC OR AUTOMATIC GUNS**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed September 14, 1964; Serial Number 396,031; Claims priority application Luxembourg, September 19, 1963; 44,465; 5 Claims. (Cl. 89–44).

3,242,813; **HOISTING APPARATUS FOR USE WITH A MOBILE GUN**; Arent Gustav Carlsson, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden, Filed November 12, 1964; Seeial Number 410,471; Claims priority, application Sweden, November 13, 1963; 12,526/63; 4 Claims; (Cl. 89–46).

3,242,814; **LOADING DEVICE FOR LOAIDNG A MAGAZINE OF A GUN**; Arent Gustav Carlsson, Kariskoga, Sweden; assignor to Aktiebilaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed November 12, 1964; Serial Number 410,4557; Claims priority, application Sweden, November 19, 1963; 12,776/63). 12 Claims. (Cl. 89–46).

3,242,815; **CARTRIDGE RAMMING DEVICE FOR INTRODUCING CARTRIDGES INTO THE CARTRIDGE CHAMBER OFTHE BARREL OF A GUN**; Carl Mayritz Christiansson, Bofors, Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed November 30, 1964; Serial Number 414,751; Claims priority, application Sweden, November 28, 1963; 13,172/63; 3 Claims. (Cl. 89–47).

3,242,816; **ACCELERATOR MECHANISM**; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed October 26, 1964; Serial Number 406,627; 5 Claims. (Cl. 89–190).

April 5, 1966

3,243,909; **GRENADE LAUNCHER**; Nicholas Kotikov, Philadelphia, Pa.; assignor to Inventors League, Inc.; Bala Cynwyd, Pa.; a corporation of Pennsylvania; Filed November 23, 1964; Serial Number 412,894; 15 Claims. (Cl. 42--1).

3,243,910; **SHOTGUN CHOKE**; Bernard Webster, 51 Canal Street, Weatogue, Conn.; Filed February 2, 1965; Serial Number 429,720; 14 Claims. (Cl. 42–79).

3,244,076; **ARRESTER DEVICE FOR PIVOTABLE COMPONENTS OF A GUN MOUNTING**; Hermann Wey, Wallisellen, Switzerland; assignor to Machine Tool Works Oerlikon, Administration Company; Zurich-Oerlikon, Switzerland; Filed August 27, 1964; Serial Number 392,518; Claims priority, application Switzerland, August 30, 1963; 10,778/63; 2 Claims. (Cl. 89–37).

April 12, 1966

3,245,167; **FIRING ACTION MECHANISM FOR FIREARMS**; George H. Freed, Change Bridge Road, Pine Brook, N.J.; Filed March 4, 1965; Serial Number 437,074; 32 Claims. (Cl. 42–65).

April 19, 1966

3,246,565; **DEVICES FOR FEEDING AMMUNITION TO AUTOMATIC GUNS BY MEANS OF CARTRIDGE BELTS**; Robert Ramseyer, Versoix, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed August 7, 1963; Serial Number 300,533; Claims priority, application Luxembourg, August 11, 1962; 42,204; 6 Claims. (Cl. 89–33).

3,246,566; **SEMI-AUTOMATIC FIREARM**; William M. Ordner, Jr., Stratford, Conn.; assignor to Eagle Gun Co., Inc.; Stratford, Conn.; a corporation of Connecticut; Filed May 13, 1964; Serial Number 366,977; 9 Claims. (Cl. 89–144).

3,246,567; **OPERATING ROD FOR SELF-LOADING FIREARM**; Arthur Miller, Costa Mesa, Calif.; assignor to Armalite, Inc., Costa Mesa, Calif.; a corporation of California; Filed June 15, 1964; Serial Number 375,256; 5 Claims. (Cl. 89–191).

April 26, 1966

3,247,610; **DUAL PURPOSE EXTRACTOR ASSEMBLY FOR MACHINE GUNS**; John M. Wallace, Indian Orchard, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 30, 1965; Serial Number 444,089; 5 Claims. (Cl. 42--25).

3,247,611; **FLINTLOCK IGNITION MECHANISM**; Curtis L. Wilson, P.O. Box 1094, Sierra Vista, Arizona; Filed April 15, 1965; Serial Number 448,552; 2 Claims. (Cl. 42--69).

May 3, 1966

3,248,817; **HAMMER COCKING LEVER FOR FIREARMS**; Dwight E. Allen, 7502 Limeklin Pike, Philadelphia, Pa.; Filed April 12, 1965; Serial Number 447,349; 7 Claims; (Cl. 42–69).

3,248,818; **SHOCK ABSORBING INSERT FOR THE COMB OF A SHOTGUN OR RIFLE**; Lee Baldock, P.O. Box 714, Woodland, California; Filed March 5, 1965; Serial Number 437,361; 1 Claim. (Cl. 42–71).

3,249,010; **ZIP CARTRIDGE**; Jim W. Bain, Audley B. Leaman, and Robert A. Nelson, Santa Cruz, and Donald C. Zapf, Ben Lomong, California; assignors to Lockheed Aircraft Corporation, Burbank, California; Filed March 30, 1965; Serial Number 443,943; 17 Claims. (Cl. 89–1).

May 10, 1966

3,250,034; **ELECTRIC GUN FIRING MECHANISM**; Ernest P. Simmons, 2510 Lafayette, Kansas City, Kans.; Filed August 5, 1964; Serial Number 387,697; 3 Claims. (Cl. 42–84).

May 17, 1966

3,251,153; **REVOLVER WITH SPRING-BIASED THRUST ARM**; Glen L. Mittelsteadt, Waseca, Minn.; assignor to Herter's Inc.; Waseca, Minn.; a corporation of Minnesota; Filed May 14, 1965; Serial Number 455,817; 4 Claims. (Cl. 42–65).

3,251,268; **TRIGGER DEVICES FOR THE MULTI-PART BREECH MECHANISMS OF AUTOMATIC FIREARMS**; Hartmut Menneking, Dusseldorf, Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed May 26, 1964; Serial Number 370,264; Claims priority, application Germany, June 1, 1963; R 35,322; 4 Claims. (Cl. 89–131).

3,251,269; FIREARM WITH BOLT ACTUATED FIRE CONTROL MECHANISM; Robert D. Whelan, West Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed September 23, 1964; Serial Number 398,817; 6 Claims. (Cl. 89–140).

3,251,270; RECOIL ABSORBER FOR AN AUTOMATIC WEAPON; Paul Seifrien, Badenweller, Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed March 5, 1964; Serial Number 349,675; Claims priority, application Germany, March 9, 1963; R 34,651; 5 Claims. (Cl. 89–177).

May 24, 1966

3,252,237; GUN BARREL SEATING DEVICE; Robert Korzeniewski, 59800 North Avenue, New Haven, Michigan; Filed September 21, 1964; Serial Number 397,877; 14 Claims. (Cl. 42–75).

3,252,238; COMPRESSIBLE REVOLVER CARTRIDGE HOLDER; William C. Bye, 169 Cypress Avenue, Bronx, N.Y.; Filed June 24, 1964; Serial Number 377,672; 3 Claims. (Cl. 42–89).

May 31, 1966

3,253,361; MOUNTS FOR TELESCOPIC SIGHT; Clark W. Kingsbury, El Paso, Texas; assignor to William R. Weaver, El Paso, Texas; Filed August 31, 1964; Serial Number 393,331; 8 Claims. (Cl. 42–1).

3,253,362; BOLT ACTIONS FOR RIFLES; Wilbur C. Gitchell, P.O. Box 283; Point Reyes Station, California; Filed April 21, 1964; Serial Number 361,429; 13 Claims. (Cl. 42--16).

3,253,511; LAUNCHING PROCESS AND APPARATUS; Fritz Zwicky, 2065 Oakdale, Pasadena, California; Filed January 11, 1961; Serial Number 82,064; 5 Claims. (Cl. 89–1.7).

3,253,512; DISINTEGRATING AMMUNITION BELT FOR AN AUTOMATIC WEAPON; Hans Georg Schallehn, Kassel, Germany; assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed July 16, 1964; Serial Number 383,071; Claims priority, application Germany, July 19, 1963; R 35,709; 6 Claims. (Cl. 89–35).

3,253,513; SEMI-AUTOMATIC OR AUTOMATIC GUNS; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed September 14, 1964; Serial Number 390,033; Claims priority application Luxembourg, September 19, 1963; 44,465; 4 Claims. (Cl. 89–190).

June 7, 1966

3,254,564; MAGNETIC GRADIENT PARTICLE ACCELERATOR; Morgan J. Morley, Berkeley, and David I. Gilbert, Walnut Creek, Calif.; assignors to Aerojet-General Nucleonics, San Ramon, California; a corporation of California; Filed December 4, 1963; Serial Number 328,025; 9 Claims. (Cl. 89–8).

3,254,565; CONNECTOR MEANS FOR LONGITUDUNALLY DISPLACEABLE CARTRIDGE BELT LINK; Clifford E. La Fever and Ralph T. Morse, Livonia, Michigan; assignors by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed September 15, 1964; Serial Number 396,780; 4 Claims. (Cl. 89–35).

June 14, 1966

3,255,545; DROP FIRE PREVENTION MECHANISM; Howard L. Chambers and Wayne E. Leek, both of Ilion, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed May 6, 1964; Serial Number 365,292; 4 Claims. (Cl. 42–70).

3,255,546; FIREARM WITH MOUNTING MEANS FOR VENTILATED THERMOPLASTIC RIB; Walter L. Dahl, Herkimer, Paul E. Eccleston, Frankfort, and Wayne E. Leek, Ilion, N.Y.; assignors to Remington Arms Company, Inc.; Bridgeport, Conn.; a corporation of Delaware; Filed December 30, 1964; Serial Number 422,241; 5 Claims. (Cl. 42–76).

3,255,547; FIREARM BOLT MECHANISM FOR FIRING ELECTRIC FILAMENT PRIMED CARTRIDGES; Leverette B. Gregory, Jr.; Spring Grove, Va .; assignor to Grego Incorporated, Petersburg, Va.; a corporation of Virginia; Filed January 28, 1965; Serial Number 428,769; 9 Claims. (Cl. 42–84).

3,255,667; BREECH TENSIONING AND DISPLACING DEVICE FOR FIREARMS; Fritz Walther, Wettersteinweg 4, Ulm (Danube), Germany; Filed March 11, 1963; Serial Number 264,309; Claims priority, application Germany, March 23, 1962; W 31,309; 1 Claim. (Cl. 89-1).

3,255,668; LIGHT ANTI-TANK WEAPONS; Jean Vilbajo, Brussels, Belgium; assignor to Contigea Societe Anonyme, Brussels, Belgium; Filed June 11, 1964; Serial Number 374,387; Claims priority application Belgium June 25, 1963, 42,732; Patent 634,048; April 23, 1964, 519,453, Patent 646,963; 4 Claims. (Cl. 89–1.7).

3,255,669; GAS-OPERATED FIREARM; Sigfrid Marenius Olofsson, P.O. Box 5880, Munkedal, Sweden; Filed March 5, 1965; Serial Number 437,480; 7 Claims. (Cl. 89–7).

June 21, 1966

3,256,632; **FOLDABLE BUTT PARTICULARLY SUITED FOR RIFLE CONVERTIBLE INTO A GRENADE THROWER**; Pier Carlo Beretta, Gardone Val Trompia, Italy; assignor to Gabbrica d'Armi P. Beretta S.p.A., Gardone Val Trompia, Brescia, Italy; a company of Italy; Filed March 10, 1965; Serial Number 438,692; Claims priority, application Italy, March 16, 1964; 5,650/64; 6 Claims. (Cl. 42–72).

June 28, 1966

3,257,749; **STRAIGHT PULL BOLT ACTION RIFLE**; Stanley Donaldson, Saguache, Colo.; assignor to Browning Industries, Inc.; a corporation of Utah; Filed November 23, 1964; Serial Number 412,958; 21 Claims. (Cl. 42–16).

3,257,905; **FIREARM ACTIVATED GENERATOR**; Sorrell D. Welsman, Valley Stream, and Gary Drucker, Yonkers, N.Y.; assignors to Kollsman Instrument Corporation, Elmhurst, N.Y.; a corporation of New York, Filed April 15, 1964; Serial Number 360,049; 3 Claims. (Cl. 89–1).

July 5, 1966

3,258,871; **KEY OPERATED SAFETY FOR FIREARMS**; Frank T. Green, Haydenville, Mass.; assignor to Noble Manufacturing Co., Inc.; Haydenville, Mass.; a corporation of Massachusetts; Filed August 4, 1965, Serial Number 477,141; 6 Claims. (Cl. 42–70).

3,259,018; **AUTOMATIC TRAVERSING MACHINE GUN UNIT**; George O. Noville, Woodland Hills, and Samuel L. Sola, Los Angeles, Calif.; assignors to the United States of America as represented by the Secretary of the Army; Filed November 9, 1956; Serial Number 621,489; 4 Claims. (Cl. 89–41).

July 12, 1966

3,260,008; **SIGHT FOR FIREARMS**; Arthur S. Yeomans, Jr., Northford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed August 3, 1964; Serial Number 386,949; 5 Claims. (Cl. 42–1).

3,260,009; **MULTI-BARREL FIREARM WITH ROTATABLE AND RECIPROCABLE HAMMER**; Robert L. Hillbert, Cheshire, Conn.; assignor to Olin Mathieson Corporation; a corporation of Virginia; Filed December 23, 1964; Serial Number 420,562; 3 Claims. (Cl. 42–69).

July 19, 1966

3,261,121; **GUN BARREL WITH EXPLOSIVELY WELDED LINER**; Joseph R. Eves, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed October 13, 1961; Serial Number 145,006; 7 Claims. (Cl. 42–78).

3,261,264; **GAS OPERATED FIREARM**; Curtis L. Wilson, Box 1094, Sierra Vista, Arizon.; Filed February 10, 1965; Serial Number 431,746; 3 Claims. (Cl. 89–193).

July 26, 1966

3,262,367; **DUAL ROTOR MACHINE GUN**; Wilford E. Martwick, Minneapolis, and Duane C. Youmans, Eden Prairie, Minn.; assignors to Honeywell Inc.; a corpruation of Delaware; Continuation of application Serial Number 352,999; March 18, 1964; This application September 28, 1965; Serial Number 495,759; 4 Claims. (Cl. 89–13).

August 2, 1966

3,263,359; **REINFORCED FIREARM RECOIL PAD**; Frank A. Pachmayr, 1220 S. Grand Avenue, Los Angeles, California, 90015; Filed August 2, 1965; Serial Number 476,589; 7 Claims. (Cl. 42–74).

3,263,566; **GUN SIGHTS PARTICULARLY FOR LIGHT DEFENSIVE WEAPONS FOR USE AGAINST MOVING AERIAL TARGETS**; Hans Eglin, Geneva, Switzerland, and Alfons Dinger, Minden, Westphalia, Germany; assignors to Mathema Corporation Reg. Trust. Vaduz, Liechtenstein; Filed October 1, 1964; Serial Number 400,640; Claims priority, application Germany, December 28, 1959; M 42,831; 13 Claims. (Cl. 89–41).

3,263,567; **GUNSIGHT DRIVE LINKAGE**; Carl R. Sandahl, Oakland, N.H.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 15, 1957; Serial Number 646,505; 4 Claims. (Cl. 89–41).

August 9, 1966

3,264,771; **SHOTGUN SIGHT**; Farnk Allen Barnes, P.O. Box 1352; Nissoula, Montana; Filed March 5, 1965; Serial Number 437,500; 4 Claims. (Cl. 42–76).

3,264,939; **FIREARM**; Eugene G. Reising, Hartford, Conn.; (c/o Harrington & Richardson Inc., Park Ave., Worchester, Mass.); Filed December 2, 1964; Serial Number 415,289; 3 Claims. (Cl. 89–145).

August 23, 1966

3,267,601; **ADJUSTABLE LENGTH BUTTSTOCK**; Robert E. Roy, East Haven, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed October 26, 1964; Serial Number 406,295; 8 Claims. (Cl. 42–73).

3,267,602; **BUTTSTOCK PAD**; Arthur Miller, Costa Mesa, Calif.; assignor to Armalite, Inc., Costa Mesa, Calif.; a corporation of California; Filed February 25, 1965, Serial Number 435,175; 2 Claims. (Cl. 42–74).

August 30, 1966

3,269,044; **BOLT RELEASE AND EJECTOR MECHANISM**; Glen L. Mittelsteadt, Waseca, Minn.; assignor to Herter's Inc., Waseca, Minn.; a corporation of Minnesota; Filed November 9, 1964; Serial Number 409,909; 5 Claims. (Cl. 42–25).

3,269,045; **REVOLVER WITH SHOOTING TRIGGER AND DIGITALLY ENGAGEABLE AUXILIARY MEANS SECURED THERETO**; Robert E. McGaughey, 51 E. 39th St., Hialeah, Fla.; Filed March 11, 1965; Serial Number 438,836; 18 Claims. (Cl. 42–65).

3,269,046; **TRIGGER SHIELD FOR FIREARMS**; Edward E. Schaefer, Winnetka, Ill. (c/o) Central Specialties Company, 3813 N. Harlem Ave., Chicago, Ill., 60634); Filed August 11, 1965; Serial Number 478,859; 18 Claims. (Cl. 42–70).

September 6, 1966

3,270,455; **SEMI-AUTOMATIC REPEATING FLARE PISTOL**; Ronald B. Smernoff, Los Angeles, Calif. (5396 Park Ave., Garden Grove, Calif.); and Russell O. Stefan, Downey, Calif. (10950 Vulcan St., South Gate, Calif.); Filed December 28, 1964; Serial Number 421,441; 8 Claims. (Cl. 42–1).

3,270,456; **BREECH-BOLT MECHANISM FOR BOLT-ACTION FIREARMS**: Carl H. Benson, New Haven, Conn.; assignor to O.F. Mossberg & Sons, Inc., North Haven, Conn.; a corporation of Connecticut; Original application December 17, 1964; Serial Number 419,061; now Patent Number 3,234,679; dated February 15, 1966; Divided and this application September 1, 1965; Serial Number 484,213; 3 Claims. (Cl. 42–16).

3,270,617; **SHELL CATCHER ATTACHED TO THE RECIPROCABLE BOLT OF A FIREARM**; Ralph V. Seymour, 110 Birch Road, Springfield, Ohio; and Carl E. Bullard, Rte. 1, Mechanicsburg, Ohio; Filed March 22, 1965; Serial Number 441,433; 15 Claims. (Cl. 89–33).

3,270,618; **CONTROLLED RECOIL WEAPON**; Albert M. Stott, Southampton, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 30, 1964; Serial Number 380,119; 4 Claims. (Cl. 89–43).

September 13, 1966

3,272,074; **MUZZLE FLASH SUPPRESSOR**; Neal L. Vinson, 836 Arizona S.E., Albuquerque, N. Mex.; Filed March 26, 1965; Serial Number 443,135; 4 Claims. (Cl. 89–14).

September 20, 1966

3,273,275; **PLASTIC BOX MAGAZINE**; Joseph A. Badali, Branford, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed December 1, 1964; Serial Number 415,034; 3 Claims. (Cl. 42–50).

3,273,460; **FIREARM WITH GAS OPERATED BREECH BLOCK UNLOCKING MEANS**; James D. Mason, 5738 Ferber St., San Diego, Calif., 92212; Filed June 14, 1965; Serial Number 463,827; 3 Claims. (Cl. 89–185).

September 27, 1966

3,274,724; **RIFLE BOLT MECHANISM**; John H. Brandt, Irving, Texas., (2120 Irving Blvd., Dallas, Texas, 75207), Filed June 1, 1965; Serial Number 459,990; 9 Claims. (Cl. 42–16).

3,274,725; **DETACHABLE FIREARM RECOIL PADS**; Frank A. Pachmayr, 1220 S. Grand Ave., Los Angeles, Calif., 90015; Filed August 2, 1965; Serial Number 476,590; 12 Claims. (Cl. 42–74).

October 4, 1966

3,276,158; **FIRING MECHANISM FOR BREAK-ACTION OVER AND UNDER FIREARM**; Harold E. Johnston, 3506 E. Indian School Road, Phoenix, Ariz., Filed July 12, 1965; Serial Number 470,979; 15 Claims. (Cl. 42–41).

3,276,322; **CARTRIDGE GUIDE FOR AN AUTOMATIC GUN**; Carl Mauritz Christianson, Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed November 24, 1964; Serial Number 413,572; Claims priority, application Sweden, November 26, 1963; 13,078/63; 4 Claims. (Cl. 89–33).

3,276,523; **SEMI-AUTOMATIC PISTOL**; Ralf E. Dieckmann, 38 Sommerville St., Fairfield, Conn.; Filed November 1, 1965; Serial Number 505,849; 9 Claims. (Cl. 89–195).

October 11, 1966

3,277,785; **FIRING MECHANISM FOR EXPLOSIVE DEVICES AND THE LIKE**; William A. Clayton, Torrance, Calif.; assignor to Harvey Aluminum (Incorporated), Torrance, Claif.; a corporation of California; Filed August 3, 1964; Serial Number 386,945; 6 Claims. (Cl. 89–1).

3,277,786; **SEMI-AUTOMATIC OR AUTOMATIC GUNS**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed September 14, 1964; Serial Number396,032; Claims priority application Luxembourg, September 19, 1963; 44,465; 12 Claims. (Cl. 89–33).

3,277,787; **DEVICE ON AN AUTOMATIC FIREARM FOR THE SELECTIVE FIRING OF TWO KINDS OF AMMUNITION FROM TWO SEPARATE BELTS**; Hans Braeger, Zurich, Switzerland, assignor to Machine Tool Works Oerlikon Administration Company, Zurich-Oerlikon, Switzerland; Filed November 23, 1964; Serial Number 413,118; Claims priority, application Switzerland, November 26, 1963; 14,464/63; 14 Claims. (Cl. 89–33).

October 18, 1966

3,279,114; **GRENADE LAUNCHER**; Karl R. Lewis, Wethersfield, and Robert E. Roy, East Haven, Conn.; assignors to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed September 25, 1964; Serial Number 401,761; 22 Claims. (Cl. 42–1).

October 25, 1966

3,280,495; **REVOLVER TYPE FIREARM WITH INTERCHANGEABLE BARRELS AND CYLINDERS**; Karl R. Lewis, 77 Olney Road, Wethersfield, Conn.; Application November 16, 1964; Serial Number 411,470; which is a division of application Serial Number 71,339; November 23, 1960; now Patent Number 3,163,951; dated January 5, 1965; Divided and this application December 8, 1965; Serial Number 512,363; 4 Claims. (Cl. 42–59).

November 1, 1966

3,281,979; **CARTRIDGE AND MAGAZINE EJECTOR**; Edward M. Stark, East Longmeadow, Mass.; assignor to Emhart Corporation, Bloomfield, Conn.; a corporation of Connecticut; Filed August 18, 1965; Serial Number 480,714; 7 Claims. (Cl. 42–25).

3,282,162; **CARTRIDGE FEEDING MECHANISM FOR AUTOMATIC GUNS**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques, S.A., Geneva, Switzerland; Filed September 14, 1964; Serial Number 396,030; Claims priority, application Luxembourg, September 19, 1963; 44,465; 18 Claims. (Cl. 89–33).

3,282,163; **LINK GUIDE MECHANISM FOR EXTERNALLY POWERED AUTOMATIC GUNS**; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 18, 1965; Serial Number 456,872; 5 Claims. (Cl. 89–33).

3,282,164; **FIELD GUN MOUNTINGS**; Roy Gilbert Vickers, Grantham, England; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed January 8, 1965; Serial Number 424,370; Claims priority, application Great Britain, January 9, 1964; 1,060/64; 5 Claims. (Cl. 89–40).

3,282,165; **PIVOTED BREECH BLOCK LOCKING MEMBER FOR AUTOMATIC GUNS**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed September 14, 1964; Serial Number 396,035; Claims priority application Luxembourg, September 19, 1963; 44,465; 4 Claims. (Cl. 89–190).

3,282,166; **GAS OPERATED AUTOMATIC GUN**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed September 14, 1964; Serial Number 396,034; Claims priority, application Luxembourg, September 19, 1963; 44,465; 5 Claims. (Cl. 89–191).

November 8, 1965

3,283,435; **BREECH CLOSURE**; Theodor Koch, Oberndorf, Germany; assignor to Heckler & Koch G.m.b.H.; Oberndorf, Germany; Filed October 27, 1964; Serial Number 406,717; Claims priority, application Germany, October 30, 1963; H 50,687; 5 Claims. (Cl. 42–16).

3,283,436; DOUBLE BARREL FIREARM WITH A SINGLE TRIGGER; Ocie Dale Bills, 1605 Burns, Franklyn E. Edwards, 1841 Burns, and Otis G. Sledge, 1629 S. Market; all of Wichita, Kansas; Filed March 8, 1965; Serial Number 437,718; 7 Claims. (Cl. 42–42).

3,283,657; METHOD FOR DIRECT PERCUSSIVE IGNITION OF STABLE EXPLOSIVES, AND APPARATUS THEREFOR; Robert C. Kvavie, Hillsboro, Oregon; assignor, by mesne assignments, to United Shoe Machinery Corporation, Boston, Mass.; a corporation of New Jersey; Filed May 29, 1964; Serial Number 371,242; 14 Claims. (Cl. 89–1).

3,283,658; BREECHBLOCK HAVING A TIMING CIRCUIT SWITCH; Frank E. Knight, Philadelphia, Howard M. Wilde, Feasterville, and Joseph W. Heaney, Philadelphia, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed May 24, 1965; Serial Number 458,521; 3 Claims. (Cl. 89–17).

November 15, 1966

3,284,942; SHOTGUN PATTERN CONTROL TUBE; William W. Moseley, 913 N. 11th Ave., Pensacola, Fla.; Filed August 26, 1965; Serial Number 482,742; 4 Claims. (Cl. 42–79).

3,285,133; GAS OPERATED SEMI-AUTOMATIC FIREARM; Walter E. Fowler, 8560 Culfor Crescent, Norfolk, Va.; Filed September 15, 1964; Serial Number 396,676; 8 Claims. (Cl. 89–191).

November 29, 1966

3,287,842; KNOCKDOWN REPEATING LEVER ACTION RIFLE;Walter H.B. Smith, deceased, late of New York, N.Y.; by Alice Denhoff, executrix, 150 W. 58th St., New York, N.Y.; Filed September 24, 1964; Serial Number 399,131; 7 Claims. (Cl. 42–16).

3,287,843; BREECH BOLT WITH FIRING PIN OPERABLE AT DIFFERENT ANGLES; Alexander W. Seidel and Tilo T. Moller, Oberndorf (Neckar), Germany, assignors to Firma Heckler & Koch G.m.b.H., Oberndorf (Neckar), Germany; Filed February 5, 1965; Serial Number 430,628; Claims priority, application Germany, February 18, 1964; H 51,729; 11 Claims. (Cl. 42–69).

3,288,029; CLOSURE DEVICE FOR A CASING DISCHARGE PORT OF A GUN; Ake Johan Arthur Birath, Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed April 1, 1965; Serial Number 444,627; Claims priority, application Sweden, April 8, 1964; 4,359/64; 5 Claims. (Cl. 89–33).

3,288,030; FIRE CONTROL SYSTEM FOR WEAPONS; Karl Goran Folke Lind, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a corporation of Sweden; Filed June 26, 1964; Serial Number 378,250; Claims priority application Sweden, July 1, 1963; 7,287; 13 Claims. (Cl. 89–41).

December 6, 1966

3,289,534; GUN ELEVATION CONTROL DEVICE; Nelmut Becker and Mulmith Frenk, Wetzlar, and Horst Schmidt, Nauborn, Kreis Wetzlar, Germany; assignors to Ernst Leitz G.m.b.H. Wetzlar, Wetzlar, Germany; a corporation of Germany; Filed May 19, 1965; Serial Number 368,580; Claims priority, application Germany, May 22, 1963; L 44,932; 8 Claims. (Cl. 89–41).

3,289,535; BREECH OPERATING MECHANISM FOR A GAS PRESSURE LOADER FOR GUNS; Gerhard Hupp, Oberndorf (Neckar), Germany; assignor to Messrs. Mauser-Werke Aktiengesellschaft, Oberndorf (Neckar), Germany; Filed March 19, 1965; Serial Number 441,035; Cliams priority, application Germany, March 20, 1964; M 60,385; 8 Claims. (Cl. 89–191).

December 13, 1966

3,290,815; FIREARM RECOIL REDUCER; Jesse B. Edwards, 269 Herbert Street, Alton, Illinois; Filed May 10, 1965; Serial Number 454,435; 5 Claims. (Cl. 42–74).

3,290,991; CARTRIDGE MAGAZINE FOR A GUN; Carl Mauritz Christiansson, Bofors, Sweden; assignor to Aktiebolaget, Bofots, Bofors, Sweden; a corporation of Sweden; Filed May 10, 1965; Serial Number 454,623; Claims priority, application Sweden May 13, 1964; 5,880/64); 4 Claims. (Cl. 89–34).

3,290,992; SMOOTHING FILTER FOR A FIRE CONTROL SYSTEM; Ake Hugo Petrus Blomqvist, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden, January 15, 1964; 499/64; 7 Claims. (Cl. 89–41).

3,290,993; RELEASE MECHANISM FOR AUTOMATIC FIREARMS; Isaac Irista, Eibar, Guipuzcoa, Spain; assignor to Star, Bonifacio Echeverria, S.A. Eibar, Guipuzcoa, Spain; a corporation of Spain; Filed June 23, 1964; Serial Number 377,272; 4 Claims. (Cl. 89–140).

December 30, 1966

3,292,492; TRIGGER MECHANISM; Foster E. Sturtevant, West Hartford, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed September 28, 1964; Serial Number 399,533; 10 Claims. (Cl. 89–128).

December 27, 1966

3,293,986; **MAGAZINE FOR BELTED AMMUNITION**; Eugene M. Stoner, Route 1, P.O. Box 70; Port Clinton, Ohio, 43452; Filed January 19, 1965; Serial Number 426,577; 12 Claims; (Cl. 89–34).

January 3, 1967

3,295,412; **MAGNETIC GRADIENT PARTICLE ACCELERATOR**; Morgan J. Morley, Berkeley, and David I. Gilbert, Walnut Creek, Calif., assignors, by mesne assignments, to Aerojet-General Corporation, El Monte, California, a corporation of Ohio; Original application December 4, 1963; Serial No. 328,025, now Patent No. 3,254,564, dated June 7, 1966. Divided and this application September 21, 1965, Serial No. 505,300; 5 Claims. (Cl. 89--8)

January 10, 1967

3,296,728; **METHOD AND APPARATUS FOR COMPENSATING FOR A CHANGE IN DIMENSION OF A FIRING PIN**; Robert C. Kvavle, Hillsboro, Oregon, assignor, by mesne assignments, to United Shoe Machinery Corporation, Boston, Mass., a corporation of New Jersey; Filed May 17, 1965; Serial No. 456,059; 23 Claims. (Cl. 42--1).

3,296,729; **REVOLVER-TYPE FIREARM WITH A BARREL ASSEMBLY INCLUDING A MULTIPLE-BORE BARREL AND A BREECH PART RELEASABLY CONNECTED THERETO**; Frederick F. Stevens, Jr., Northford, Conn. (R.F.D. 1, Sandy Hook, Conn., 06482); Filed August 30, 1965; Serial Number 483,576; 21 Claims. (Cl. 42--59).

3,296,930 **CLUTCH-LOCK FOR EXTERNALLY POWERED FIREARM FEEDING MECHANISM**; John G. Rocha, Westfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed February 23, 1965; Serial No. 434,717; 3 Claims. (Cl. 89--33).

3,296,931; **DEVICE FOR CONTROLLING A HYDRAULICALLY OR PNEUMATICALLY DRIVEN CARTRIDGE RAMMING MECHANISM OF AN AUTOMATIC GUN**; Carl Mauritz Christiansson, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed November 24, 1964; Serial No. 413,514; Claims priority, application Sweden, November 26, 1963; 13,079/63; 1 Claim. (Cl. 89--47).

January 17, 1967

3,298,125; **TEAR GAS GUN**; Robert G. Adrian, 2915 Waldorf Avenue, Camden, N.J. 08105, and Willison L. Lower, 2421 45th Street, Pennsauken, N.J. 08110; Filed September 20, 1965; Serial No. 488,424; 4 Claims. (Cl. 42--1).

3,298,279; **GLASS REINFORCED PLASTICS RECOILLESS RIFLE**; Fredrick R. Barnet, Kensington, and Stanley P. Prosen, Lanham, Md., assignors to the United States of America as represented by the Secretary of the Navy; Filed January 8, 1965; Serial No. 425,117; 10 Claims. (Cl. 89--1.814)

3,298,280; **GUN STABILIZER**; Joseph L. Rahm, 7508 La Grange Road, Louisville, Ky. 40222; Filed March 22, 1965; Serial No. 441,720; 7 Claims. (Cl. 89--14).

3,298,281; **DEVICE FOR COMPUTING THE DISPLACEMENT OF THE LINE OF AIM FOR FIRE ARMS**; Niles Edvard Hoglund, Rotebro, Sweden, assignor to Forsvarets Fabriksstyrelse, Stockholm, Sweden; Filed July 20, 1964; Serial No. 383,894; Claims priority, application Sweaden, September 25, 1963; 10,448/63; 4 Claims. (Cl. 89--41).

3,298,282; **BUFFER SYSTEMS FOR AUTOMATIC FIREARMS**; Theodore Loffier, Mullheim, and Karl Harbrecht, Elsental, near Buhl, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed February 16, 1965; Serial No. 432,972; Claims priority, application Germany, February 22, 1964; R 37,279; 3 Claims. (Cl. 89--198).

January 24, 1967

3,299,558; **METAL GUN BARREL WITH ENCIRCLING PLASTIC LAYER AND INTEGRAL PLASTIC SIGHT**; Anthony Robert Karl, 4 Walnut Street, Rye, N.Y. 10580; Filed August 27, 1965; Serial No. 483,083; 6 Claims. (Cl. 42--76).

January 31, 1967

3,300,888; **UNDERWATER GUN**; Gary Lee Belcher, Coral Gables, and Robert E. Schroeder and Walter A. Starck II, Islamorada, Fla., assignors to Bangstick Corporation, Miami, Fla., a corporation of Florida; Filed January 9, 1964; Serial No. 336,757; 12 Claims. (Cl. 42--1).

3,300,889; **RECOIL SNUBBER FOR GUNS**; Stephen C. Baker, Detroit, Michigan, assignor to Su-Ev, Inc., Birmingham, Michigan, a corporation of Michigan; Filed April 22, 1965; Serial No. 450,059; 3 Claims. (Cl. 42--74).

3,301,133; **MECHANISM FOR CHANGING RATE OF AUTOMATIC FIRE**; Foster E. Sturtevant, West Hartford, conn., assignor to Colt's Inc., Hartford, Conn., a corporation of Arizona; Filed January 21, 1965; Serial No. 426,737; 14 Claims. (Cl 89--131).

February 7, 1967

3,302,319; **DEVICES FOR FIRING OBJECTS OF THE CLASS OF PROJECTILES, PLUGS, PINS AND NAILS**; Claude Rosselet, Founex, near Nyon, Switzerland, assignor to Corat S.A., Compagnie de Recherches et d'Applications Techniques, Lenzerheide, Grisons, Switzerland, a Swiss company; Filed April 16, 1965; Serial No. 448,624; Claims priority, application France, April 22, 1964, 971,871, Patent 1,422,054; 2 Claims. (Cl. 42--1).

3,302,523; **AIR OPERATED PROJECTILE FIRING APPARATUS**; Jules Edmond Van Langenhoven and Eugene Elton Billingslea, Rogers, Leopold C. Sage, Fayetteville, James C. Adams, Rogers, and Ronald W. Joyce, Springdale, Ark., assignors to Daisy Manufacturing Company, Rogers, Ark., a corporation of Nevada; Filed July 7, 1965; Serial No. 470,028; 16 Claims. (Cl. 89--7).

3,302,524; **CARTRIDGE STOP MEANS FOR EXTERNALLY POWERED AUTOMATIC GUNS**; Clifford E. La Fever, Livonia, and Jerome Deja, Dearborn Heights, Michigan, assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed October 12, 1965; Serial No. 495,358; 7 Claims. (Cl. 89—33).

3,302,525; **MISSILE LOADING TRAY FOR BREECH-LOADED GUN-LAUNCHERS**; James P. Halne, Santa Ana, California, assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed May 6, 1965; Serial No. 455,042; 3 Claims. (Cl. 89—45).

February 14, 1967

3,303,594; **FIREARM BARREL, SHROUD, FRAME, AND CYLINDER CONSTRUCTION**; Karl R. Lewis, 54 Folly Brook Blvd., Wethersfield, Conn. 06109; Application November 16, 1964; Serial No. 411,470, which is a division of application Serial No. 71,339, November 23, 1960, now Patent No. 3,163,951, dated January 5, 1965. Divided and this application December 14, 1965; Serial No. 517,503; 13 Claims. (Cl. 42—59).

3,303,741; **CARTRIDGE MAGAZINE OF A GUN**; Carl Mauritz Christiansson, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed April 1, 1965; Serial No. 444,628; Claims priority, application Sweden, April 8, 1964; 4,360/64; 2 Claims. (Cl. 89—34).

3,303,742; **FULL BALL AND SOCKET ASSEMBLY**; Robert J. Thierry, Averill Park, and Stephen C. Horvath, Troy, N.Y., assignors to the United States of America as represented by the Secretary of the Army; Filed May 18, 1965; Serial No. 456,870; 5 Claims. (Cl. 89—37).

3,303,743; **FIRING PIN SAFETY MECHANISM FOR AN EXTERNALLY POWERED AUTOMATIC GUN**; Charles E. Lanizzani, Stafford, Conn., assignor to the United States of America as represented by the Secretary of the Army; Filed March 13, 1963; Serial No. 265,593; 6 Claims. (Cl. 89—149).

3,303,744; **BARREL SURROUNDING MOUNT FOR OPERATING DRUM OF EXTERNALLY POWERED AUTOMATIC GUN**; Charles E. Lanizzani, Stafford, Conn., assignor to the United States of America as represented by the Secretary of the Army; Filed December 14, 1962; Serial No. 246,862; 6 Claims. (Cl. 89—161).

February 21, 1967

3,304,643; **FIREARM ACTION**; William J. Nittler, 2110 32nd Avenue, San Francisco, Calif. 94116; Filed June 23, 1965; Serial No. 466,324; 3 Claims. (Cl. 42—42).

February 28, 1967

3,306,163; **PROJECTILE FIRING DEVICE**; Jean-Jacques Griessen, Geneva, Switzerland, assignor to Transurvey Holding Company, Inc., Societe Anonyme, Panama, Panama; Filed July 29, 1964; Serial No. 385,859; Claims priority, application Switzerland, May 12, 1964, 6,178/64; May 27, 1964, 6,936/64; 8 Claims. (Cl. 89—1).

3,306,165; **DEVICE FOR FEEDING CARTRIDGES OF AMMUNITION OUT OF A CARTRIDGE MAGAZINE OF AN AUTOMATIC GUN**; Carl Mauritz Christiansson, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed January 6, 1965; Serial No. 423,783; 5 Claims. (Cl. 89—33).

3,306,166; **GUN TRAINING MECHANISM WITH TRIGGER**; Robert Ramseyer, Versoix, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed March 5, 1965; Serial No. 437,407; Claims priority, application Luxembourg, March 12, 1964, 45,645; 3 Claims. (Cl. 89—41).

3,306,167; **AUXILIARY CONTROL OF A GUN FIRING MECHANISM**; Robert Ramseyer, Versoix, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed March 8, 1965; Serial No. 437,947; Claims priority, application Luxembourg, March 17, 1964, 45,672; 5 Claims. (Cl. 89—132).

3,306,168; **GAS OPERATED SEMI-AUTOMATIC PISTOL**; Howard J. Blumrick, 749 N. 98th St., Seattle, Wash. 98103; Filed August 16, 1965; Serial No. 483,008; 12 Claims. (Cl. 89—191).

March 7, 1967

3,307,283; **FIREARM GRENADE LAUNCHER**; Wilbur C. Cox, Lyndhurst, Ohio, assignor to Lake Erie Chemical Company, Rock Creek, Ohio, a corporation of Ohio; Filed September 29, 1965; Serial No. 491,274; 2 Claims. (Cl. 42—1).

3,307,451; **PRESSURE CONTROL DEVICE**; Ludwig Bucklisch, Rhondorf, and Ludger Volpert, Spich, Germany, assignors to Dynamit Nobel Aktiengesellschaft, Troisdorf, Germany; Filed October 1, 1964; Serial No. 400,745; Claims priority, application Germany, October 2, 1963, D 42,618; 10 Claims. (Cl. 89—1.701).

3,307,452; **ONE-PIECE CHUTING**; Robert Meunier, Springfield, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed June 9, 1965; Serial No. 462,765; 6 Claims. (Cl. 89—33).

March 21, 1967

3,309,962; **GUN MOUNT AND GUNSIGHT ASSEMBLY**; Clarence W. Lykam, San Jose, Calif., assignor to FMC Corporation, San Jose, Calif., a corporation of Delaware; Filed March 1, 1965; Serial No. 435,947; 15 Claims. (Cl. 89—41).

3,309,963; FIRE CONTROL SYSTEM FOR AN ANTI-AIRCRAFT WEAPON CARRIER; Hans Manne Alvar Salomonsson, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish company; Filed April 27, 1965; Serial No. 451,179; Claims priority, application Sweden, May 5, 1964; 5,582/64; 8 Claims. (Cl. 39–41).

March 28, 1967

3,311,020; MULTIPLE PISTON TWO-STAGE LIGHT GAS LAUNCHER; Robert Piacesi and Robert H. Waser, Silver Spring, Md., assignors to the United States of America as represented by the Secretary of the Navy; Filed March 11, 1965; Serial No. 439,109; 4 Claims. (Cl. 89–8).

3,311,021; FEED MECHANISM; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed April 30, 1965; Serial No. 452,412; 9 Claims. (Cl. 89–33).

3,311,022; GAS DRIVE FOR AUTOMATIC GUN WITH ROTATING BARREL CLUSTER; Robert R. Bernard, Essex Junction, Robert E. Chiabrandy, Burlington, Gerard H. Donovan, Essex Junction, and James Seemann, South Burlington, Vt., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed December 1, 1965; Serial No. 511,306; 7 Claims. (Cl. 89–126).

April 11, 1967

3,313,207; UNDERWATER WEAPON; Arthur T. Biehl, Calle los Calados, and Robert Mainhardt, Calle Arroyo, both of Diablo, Calif. 94528; Original application April 2, 1965; Serial No. 445,277. Divided and this application October 22, 1965; Serial No. 514,426; 7 Claims. (Cl. 89–1.813).

3,313,208; LIQUID PROPELLANT FOR SMALL CALIBER GUN; Edward G. Dorsey, Jr., Bernard A. Niemeier, and Eugene T. Fleischhauer, Richmond, Va., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed March 25, 1953; Serial No. 344,652; 11 Claims. (Cl. 89–7).

3,313,209; ARTILLERY FIRE CONTROL SYSTEM; Malcolm F. Thompson, Santa Ana, Calif., assignor to North American Aviation, Inc.; Filed June 24, 1965; Serial No. 466,613; 3 Claims. (Cl. 89–41).

April 18, 1967

3,314,182; DUAL MAGAZINE SYSTEM FOR FIREARMS; Earle M. Harvey, Agawam, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed October 11, 1965; Serial No. 494,989; 4 Claims. (Cl. 42–13).

3,314,183; FIREARM; Warren A. Center, Westminster, Mass., assignor to Harrington & Richardson, Inc., Worchester, Mass., a corporation of Massachusetts; Filed December 2, 1964; Serial No. 415,307; 3 Claims. (Cl. 42–69).

3,314,332; CARTRIDGE-GUIDING DEVICE OF AN AUTOMATIC GUN; Sten Olov Wallin, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed May 19, 1965; Serial No. 456,970; Claims priority, application Sweden, May 21, 1964; 6,202/64; 8 Claims. (Cl. 89–45).

April 25, 1967

3,315,397; FLARE GUN HAVING QUICK DISCONNECT COUPLING; Clarence W. Gilliam, Crane, and Richard D. Smith and John E. Wildridge, Washington, Ind., and Raymond W. Szypulski, Berwyn Heights, Md., assignors to the United States of America as represented by the Secretary of the Navy; Filed November 29, 1965; Serial No. 510,478; 3 Claims. (Cl. 42–1).

3,315,566; GUN-CARRIAGE; Hans Klapdohr, Erkrath, Franz Horn, Osterath (Lower Rhine), and Erich Zielinski, Dusseldorf, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed July 26, 1965; Serial No. 474,579; Claims priority, application Germany, July 28, 1964; R 38,474; 16 Claims. (Cl. 89–40).

3,315,567; AUTOMATIC LAUNCHER FOR ROCKET-BOOSTED AMMUNITION; Kenneth J. J. McGowan, Richmond, Ind., assignor to Avco Corporation, Richmond, Ind., a corporation of Delaware; Filed August 10, 1965; Serial No. 478,570; 6 Claims. (Cl. 89–183).

May 2, 1967

3,316,810; MULTIPLE SHOTGUN FIRING MECHANISM; Mitchell G. Angelos, Cockeysville, Robert W. Schnepfe, Timonium, and Jacob Sofinowski III, Westminster, Md., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed August 26, 1965; Serial No. 482,954; 3 Claims. (Cl. 89–28).

May 9, 1967

3,318,033; GRENADE LAUNCHING ARRANGEMENT; Irwin R. Barr, Lutherville, Md., assignor to AAI Corporation, Cockeysville, Md., a corporation of Maryland; Filed September 29, 1965; Serial No. 491,309; 10 Claims. (Cl. 42–1).

3,318,034; MOUNTING MECHANISM; Albert M. Stott, Southampton, and Osyp Nimylowycz, Philadelphia, Pa., assignors to the United States of America as represented by the Secretary of the Army; Filed December 10, 1965; Serial No. 513,127; 3 Claims. (Cl. 42–1).

3,318,188; HAND WEAPON; Mathew C. Hengel, Hayward, and Arthur T. Biehl and Robert Mainhardt, Diablo, Calif., assignors to MB Associates, a corporation of California; Original application November 29, 1961; Serial No. 240,784, now Patent No. 3,212,402, dated October 19, 1965. Divided and this application August 12, 1965; Serial No. 534,541; 7 Claims. (Cl. 89–1.806).

3,318,189; **AUTOMATIC WEAPON, MOUNTED IN AN ARMOURED TURRET**; Karl Fammler, Dusseldorf, and Richard Koine, Dusseldorf-Neulichtenbroich, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed January 27, 1966; Serial No. 523,304; Claims priority, application Germany, February 6, 1965; R 39,836; 9 Claims. (Cl. 89–33).

3,318,190; **ELEVATING MECHANISM**; Anthony J. Suchocki, Clawson, Michigan, assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed June 16, 1965; Serial No. 464,588; 5 Claims. (Cl. 89–41).

3,318,191; **MACHINE GUN WITH A MOUNT FOR REDUCING THE RECOIL FORCES APPLIED TO THE TRUNNIONS**; Frederick P. Reed, Ludlow, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed July 9, 1965; Serial No. 470,942; 4 Claims. (Cl. 89–42).

3,318,192; **LOCKED ACTION RIFLE FOR AUTOMATIC AND SEMI-AUTOMATIC SELECTIVE FIRING**; Arthur Miller and Charles H. Dorchester, Costa Mesa, and George C. Sullivan, North Hollywood, Calif., assignors to Armalite, Inc., Costa Mesa, Calif., a corporation of California; Filed February 12, 1965; Serial No. 432,198; 8 Claims. (Cl. 89–142).

May 16, 1967

3,319,520; **HIGH SPEED LOW SHOCK SEPARATION SYSTEM**; Nicholas M. Stefano, Rolling Hills, Stanley H. Rush, Chatsworth, and Stanley L. Green, Gardena, California, assignors to TRW Inc., Redondo Beach, California, a corporation of Ohio; Filed June 23, 1965; Serial No. 466,387; 9 Claims. (Cl. 89–1).

3,319,522; **LAUNCHING DEVICE**; Ben B. Gould, Berkeley, and Arthur T. Biehl, Diablo, California, assignors to MB Associates, a corporation of California; Filed February 16, 1965; Serial No. 433,547; 10 Claims. (Cl. 89–1.813).

3,319,523; **DRUM CARTRIDGE FEEDING MECHANISM**; Richard J. Casull, Salt Lake City, Utah, assignor of one-half to Richard J. Casull and Geraldine Casull, Salt Lake City, Utah, as joint tenants in common, and one-half to K. R. Eskelsen and Fern P. Eskelsen, Sandy, Utah, as joint tenants in common; Filed August 27, 1964; Serial No. 392,540; 10 Claims. (Cl. 89–33).

3,319,524; **TRANSFER MECHANISM FOR AMMUNITION**; Douglas P. Tassie, St. George, Vt., assignor to General Electric Company, a corporation of New York; Filed November 30, 1965; Serial No. 510,526; 7 Claims. (Cl. 89–33).

3,319,525; **UNLOADING MECHANISM FOR AN AUTOMATIC GUN**; Erik Wilhelm Jafwert, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish company; Filed July 30, 1965; Serial No. 476,080; Claims priority, application Sweden, August 14, 1964, 9,884/64; 3 Claims. (Cl. 89–45).

May 23, 1967

3,320,855; **EXTERIOR FEED MECHANISM FOR AUTOMATIC GUNS**; Frederick P. Reed, Ludlow, and Albert J. Lizza, Wilbraham, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed March 24, 1966; Serial No. 538,186; 8 Claims. (Cl. 89–11).

3,320,856; **FIREARM HAVING INTERNALLY SEALED BREECH BLOCK**; William A. Robinson, P.O. Box 242, Towaco, N.J., 07082; Filed October 19, 1965; Serial Number 497,862; 7 Claims. (Cl. 89–17).

3,320,857; **SUPPLY CASE FOR A CARTRIDGE MAGAZINE OF A GUN**; Arent Gustav Carlsson, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed June 9, 1965; Serial No. 462,495; Claims priority, application Sweden, June 15, 1964, 7,284/64; 8 Claims. (Cl. 89–34).

May 30, 1967

3,322,036; **ROUND FEEDING MECHANISM FOR AN AUTOMATIC GUN**; Erik Wilhelm Jafwert, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish Company; Filed July 30, 1965; Serial No. 475,939; Claims priority, application Sweden, August 14, 1964, 9,883/64; 6 Claims. (Cl. 89–45).

June 6, 1967

3,323,245; **EJECTOR DISCONNECTING DEVICE FOR DOUBLE BARRELED GUNS HAVING AN UPPER AND A LOWER BARREL**; Kosaburo Fukami, Nangoku-shi, Japan, assignor to Kabushiki Kaisha Miroku Seisakusho, Kochi-ken, Japan; Filed December 2, 1964; Serial No. 511,184; Claims priority, application Japan, April 30, 1965, 40/25,801; 2 Claims. (Cl. 42–48).

3,323,246; **AUTOMATIC FIREARM ASSEMBLY**; Theodor Loffler, Mullheim, Baden, Germany, assignor to Rheinmetall GmbH, Dusseldorf, Germany, a German company; Filed October 26, 1965; Serial No. 505,269; Claims priority, application Germany, October 29, 1964, R 39,129; 10 Claims. (Cl. 42–75).

3,323,418; **BARREL AND GAS DUCT ASSEMBLY MEANS FOR SEMI-AUTOMATIC FIREARMS**; Theodor Loffler, Mullheim, Baden, Germany, assignor to Rheinmetall G.m.b.H., Dusseldorf, Germany, a German company; Filed October 26, 1965; Serial No. 505,265; Claims priority, application Germany, October 29, 1964, R 39,131; 5 Claims. (Cl. 89–191).

June 13, 1967

3,324,587; **CHEEK-OPERATED SAFETY FOR GUNS**; Harvard J. Bryan, 9303 Sorrento, Dallas, Texas 75228; Filed December 13, 1965; Serial No. 513,507; 10 Claims. (Cl. 42–70).

3,324,588; **GUNSTOCK**; William V. T. Gilbert 3165 Ferndale, Las Vegas, Nev. 89109; Filed September 27, 1965; Serial No. 490,180; 7 Claims. (Cl. 42–71).

3,324,767; **UNDERWATER GUN**; John M. Alban, 51 Tower Place, Yonkers, N. Y. 10703; Filed February 26, 1965; Serial No. 435,659; 6 Claims. (Cl. 89–1).

3,324,768; **PANELS FOR PROTECTION OF ARMOR AGAINST SHAPED CHARGES**; Robert J. Eichelberger, Pittsburgh, Pa., assignor to the United States of America as represented by the Secretary of the Army; Filed May 22, 1950; Serial No. 163,386; 2 Claims. (Cl. 89–36).

June 20, 1967

3,325,937; **VENTILATED RIB SIGHT**; Edward L. Morrow, Fairfield, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed August 25, 1965; Serial No. 482,504; 2 Claims. (Cl. 42–1).

3,326,082; **FIXED-ANGLE VARIABLE-RANGE MARKER LAUNCHER**; Edward W. Johnson, Jr., and James M. Seawright, Panama City, Florida, assignors to the United States of America as represented by the Secretary of the Navy; Filed September 30, 1965; Serial No. 491,649; 3 Claims. (Cl. 89–1).

3,326,084; **LIGHT GAS CARTRIDGE**; Louis J. Barbieri, Tustin, and Seymour Lampert, Santa Ana, Calif., assignors to North American Aviation, Inc.; Filed April 23, 1965; Serial No. 450,398; 10 Claims. (Cl. 89–7).

3,326,085; **AUTOMATIC FEED MECHANISM FOR A GUN**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Filed February 23, 1965; Serial No. 434,572; Claims priority, application Luxembourg, February 24, 1964, 45,519; 3 Claims. (Cl. 89–33).

June 27, 1967

3,327,421; **RIGHT AND LEFT HAND PISTOL GRIP**; Philip Finkelstein, 805 Via Conejo, Palos Verdes, Estates, Calif. 90274; Filed September 28, 1965; Serial No. 491,060; 1 Claim. (Cl. 42–71).

3,327,422; **BIPOD FOR ATTACHMENT TO A FIREARM**; Gerald Harris, 8015 Agnes, Detroit, Mich. 48214; Filed October 23, 1965; Serial No. 503,642; 19 Claims. (Cl. 42–94).

3,327,587; **ROTARY CAM ACTUATED OPERATING ROD MECHANISM**; Frederick P. Reed, Ludlow, Albert J. Lizza, North Wilbraham, and Robert Meunier, Palmer, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed September 7, 1965; Serial No. 485,657; 5 Claims. (Cl. 89–161)

July 4, 1967

3,329,063; **ROCKET MACHINE GUN**; Frederick K. Ehrenburg, Walnut Creek, and Robert Mainhardt, Diablo, Calif., assignors to MB Associates, a corporation of California; Filed April 14, 1965; Serial No. 448,001; 12 Claims. (Cl. 89–1.801).

3,329,064; **GAS OPERATED BOLT MECHANISM**; Doyle E. Segrest, P. O. Box 431, Woodville, Texas 75979; Filed September 15, 1965; Serial No. 487,372; 9 Claims. (Cl. 89–191)

July 11, 1967

3,330,061; **RIFLE BOLT ACTION**; Homer E. Koon, Jr., Gainesville, Texas, assignor to Brandt Arms, Inc., Gainesville, Texas, a corporation of Texas; Filed August 26, 1965; Serial No. 482,633; 16 Claims. (Cl. 42–16).

3,330,183; **GAS AND MANUAL OPERATION ASSEMBLY FOR SEMI-AUTOMATIC FIREARMS**; Theodor Loffler, Mullheim, Baden, Germany, assignor to Rheinmetall G.m.b.H., Dusseldorf, Germany, a German company; Filed October 26, 1965; Serial No. 505,264; Claims priority, application Germany, October 29, 1964, R 39,132; 3 Claims. (Cl. 89–191).

July 18, 1967

3,331,280; **FIRING MECHANISM**; C. Walton Musser, Palos Verdes Estates, Calif., assignor to the United States of America as represented by the Secretary of the Army; Filed May 4, 1966; Serial No. 547,675; 4 Claims. (Cl. 89–27).

3,331,281; **ROUND FEEDING MECHANISM FOR AUTOMATIC GUNS FOR DISCHARGING ROUNDS FROM A ROUND MAGAZINE**; Erik Wilhelm Jafvert, Karlskoga, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a Swedish company; Filed March 7, 1966; Serial No. 534,967; Claims priority, application Sweden, March 10, 1965, 3,142/65; 8 Claims. (Cl. 89–33).

3,331,282; **AMMUNITION FEEDER FOR AUTOMATIC LAUNCHER FOR ROCKET-BOOSTED AMMUNITION**; Kenneth J. J. McGowan, Richmond, Ind., assignor to Avco Corporation, Richmond, Ind., a corporation of Delaware; Original application August 10, 1965; Serial No. 478,570, now Patent No. 3,315,567, dated April 25, 1967. Divided and this application November 1, 1966; Serial No. 591,288; 11 Claims. (Cl. 89–33).

3,331,283; **SEAR LOCK AND RELEASE MECHANISM FOR DIFFERENTIAL RECOIL GUNS**; Bengt I. Piskator, Chicopee Falls, and Walter S. Draper III, Palmer, Mass., assignors to the United States of America as represented by the Secretary of the Army; Filed April 13, 1966; Serial No. 542,712; 4 Claims. (Cl. 89–42).

3,331,284; **ELECTRICAL CONTROL SYSTEM FOR RECOILLESS CANNON**; Frank H. Case, Jr., Edgar Losberg, and Corbet M. Cornelison, all of Huntsville, Ala., assignors to the United States of America as represented by the Secretary of the Army; Filed February 4, 1966; Serial No. 525,808; 7 Claims. (Cl. 89–126).

July 25, 1967

3,332,162; **COMBINED RIFLE AND GRENADE LAUNCHER**; Wilford E. Martwick, Minneapolis and Duane C. Youmans, Eden Prairie, Minn., assignors to Honeywell, Inc., Minneapolis, Minn., a corporation of Delaware; Filed December 22, 1965; Serial No. 526,647; 6 Claims. (Cl. 42—1).

August 1, 1967

3,333,506; **SIDE STRIPPING MECHANISM FOR LINKED AMMUNITION**; Robert W. Henshaw, Burlington, and Douglas P. Tassie, St. George, Vt., assignors to General Electric Company, a corporation of New York; Filed June 7, 1965; Serial No. 461,666; 5 Claims. (Cl. 89—33).

3,333,507; **ARMORED VEHICLES INCLUDING A TURRET FITTED WITH AN AUTOMATIC GUN FED FROM CARTRIDGE BELT SECTIONS PACKED IN BOXES**; Rene de Meiss, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Filed October 25, 1965; Serial No. 505,155; Claims priority, application Luxembourg, November 7, 1964; 9 Claims. (Cl. 89—36).

3,333,508; **CLOSED BREECH GUN UTILIZING A HOLLOW BOLT AND A FIRING PIN AS A GAS CYLINDER AND A PISTON, RESPECTIVELY**; George R. Kruzell, 301 Hotchkiss, Bay City, Michigan 48706; Filed January 30, 1967; Serial No. 612,376; 10 Claims. (Cl. 89—179).

3,333,509; **OBTURATING PISTON FOR AN AUTOMATIC WEAPON WITH A GAS-BLEED PASSAGE**; Ernst Muhlemann, Zurich, Switzerland, assignor to Oerlikon-Buhrle Holding A.G., Zurich, Switzerland; Filed October 19, 1965; Serial No. 497,946; Claims priority, application Switzerland, October 20, 1964, 13,620/64; 4 Claims. (Cl. 89—193).

3,333,510; **PISTON RING FOR AUTOMATIC WEAPON WITH BREECH-UNLOCKING PISTON**; Ernst Muhlemann, Zurich, Switzerland, assignor to Oerlikon-Buhrle Holding A.G., Zurich, Switzerland; Filed October 22, 1965; Serial No. 501,399; Claims priority, application Switzerland, November 11, 1964, 14,548/64; 3 Claims. (Cl. 89—193).

August 8, 1967

3,334,435; **TRIGGER MECHANISM**; Abraham T. Tonkin, 35 E. 73rd Street, New York, N. Y. 10021; Filed October 20, 1965; Serial No. 498,594; 4 Claims. (Cl. 42—42).

August 15, 1967

3,335,515; **ANTI-RECOIL DEVICE FOR GUNS**; Ralph E. Bennett, 1011 Maryvale Drive, Cheektowaga, N.Y., 14225; Filed September 24, 1965; Serial No. 489,592; 2 Claims. (Cl. 42—74).

3,335,637; **PROJECTILE PROPELLED BY FRICTION DRAG OF HIGH VELOCITY PLASMA**; Fay E. Null, Shalimar, and Raymond K. Vermillion, Valparaiso, Fla., assignors to the United States of America as represented by the Secretary of the Air Force; Filed December 23, 1965; Serial No. 516,168; 8 Claims. (Cl. 89—1).

August 22, 1967

3,336,691; **FIREARM**; Harold D. Allyn, 10 Sumner Ave., Springfield, Mass. 01108; Filed September 9, 1965; Serial No. 485,990; 3 Claims. (Cl. 42—75).

3,336,838; **MACHINE PISTOL HAVING HYDRAULIC BREECH LOCKING AND OBTURATION**; Curtis L. Wilson, 3103 Elizabeth, Space 25, Pueblo, Colorado 81003; Filed January 27, 1966; Serial No. 523,474; 2 Claims. (Cl. 89—197).

August 29, 1967

3,337,979; **FIRING MECHANISM FOR FIREARMS**; George H. Freed, Change Bridge Road, Pine Brook, N.J. 07058; Filed October 24, 1965; Serial No. 504,931; 18 Claims. (Cl. 42—65).

3,338,133; **LAUNCHING SYSTEM**; Andrew J. Grandy, North Hills, Pa., assignor to the United States of America as represented by the Secretary of the Army; Filed October 6, 1965; Serial No. 493,591; 4 Claims. (Cl. 89—1.703).

September 5, 1967

3,339,304; **SHOTGUN GAUGE ADAPTER**; Oliver M. Knode, Jr., Hampden, and Edward M. Stark, East Longmeadow, Mass., assignor to Emhart Corporation, Bloomfield, Conn., a corporation of Connecticut; Filed October 23, 1965; Serial No. 503,211; 1 Claim. (Cl. 42—77).

3,339,457; **FIRE CONTROL SYSTEMS**; Lucas Pun, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Filed June 21, 1965; Serial No. 465,394; Claims priority, application Luxembourg, June 26, 1965, 46,404; August 18, 1964, 46,787; 18 Claims. (Cl. 89—41).

September 12, 1967

3,340,641; **METHOD AND MEANS FOR IMPROVING THE ACCURACY OF FIREARMS BY REDUCING BARREL VIBRATIONS**; Kenneth H. Recker, Melbourne, Fla., assignor to Heli-Pic, Inc., a corporation of Florida; Filed December 15, 1964; Serial No. 418,486; 12 Claims. (Cl. 42—1).

3,340,769; GUN BLAST AND MUZZLE FLASH ELIMINATOR; Robert H. Waser, Silver Spring, Md., assignor to the United States of America as represented by the Secretary of the Navy; Filed September 24, 1965; Serial No. 490,145; 3 Claims. (Cl. 89–14).

3,340,770; ROUND STOP DEVICE FOR A MACHINE GUN FEEDING MECHANISM; Edward A. Santos, Thompsonville, Conn., assignor to the United States of America as represented by the Secretary of the Army; Filed March 2, 1966; Serial No. 533,129; 3 Claims. (Cl. 89–33).

3,340,771; ARMOURED VEHICLES HAVING TURRETS MOUNTING GUNS IN CYLINDRICAL DRUM HOUSINGS; Rene de Meiss, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a Swiss society; Filed November 9, 1965; Serial No. 507,076; Claims priority, application Luxembourg, November 24, 1964, 47,432; 1 Claim. (Cl. 89–36).

September 19, 1967

3,341,963; BOLT ACTION FOR FIREARMS HAVING A RIGHT OR LEFT HAND OPERATING HANDLE; Abe Seiderman, Coral Gables, Florida, assignor to Universal Firearms Corp., Hialeah, Florida, a corporation of Florida; Filed August 9, 1966; Serial No. 571,307; 6 Claims. (Cl. 42–16).

3,342,105; BOLTLESS GATLING GUN MECHANISM; Emile J. Fagerstrom, 213 Baker Avenue N.W., Fort Walton Beach, Florida 32548; Filed January 28, 1966; Serial No. 523,805; 7 Claims. (Cl. 89–12).

September 26, 1967

3,343,295; REVOLVER LOADER; Gregory Grosbard and Daniel L. Lazenberry, El Paso, Texas, assignors of two percent to Taxas S. Ward, El Paso, Texas, Four percent to Max Brooks, ten percent to Donald L. Lozow, and one percent to Marvin Smith, Morey A. Brooks, and Steve P. Levine, jointly, all of Denver, Colorado; Filed August 5, 1966; Serial No. 570,508; 9 Claims. (Cl. 42–89).

3,343,455; GUN; Riley Lohr, Lancaster, Pa., assignor to John H. Hartman, Jr., Strasburg, Pa.; Filed September 8, 1965; Serial No. 485,890; 6 Claims. (Cl. 89–7).

3,343,456; CONTROL DEVICE FOR A CARTRIDGE MAGAZINE OF A GUN; Carl Mauritz Christiansson, Bofors, Sweden, assignor to Aktiebolaget Bofors, Bofors, Sweden, a corporation of Sweden; Filed May 10, 1965; Serial No. 454,624; Claims priority, application Sweden, May 13, 1964, 5,881/64; 3 Claims. (Cl. 89–33).

3,343,457; HOUSING STRUCTURE FOR AN AUTOMATIC FIREARM; Hartmut Menneking and Hermann Henning, Dusseldorf, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed December 10, 1965; Serial No. 512,901; Claims priority, application Germany, December 19, 1964, R 39,534; 5 Claims. (Cl. 89–199).

October 3, 1967

3,344,546; SINGLE TRIGGER MECHANISM FOR A DOUBLE-BARRELED SHOTGUN; Dewey M. Morrison, Rte. 1, Walkertown, N. C. 27051; Filed October 27, 1965; Serial No. 505,331; 10 Claims. (Cl. 42–42).

3,344,711; JAVELIN STABILIZED QUIET ROUND; Robert C. Mawhinney, 4661 HEYER Avenue, Castro Valley, California 94546; Bert F. Gould, P. O. Box 820, Berkeley, California 94701; Arthur T. Biehl, General Delivery, and Robert Mainhardt, P. O. Box 225, both of Diablo, California 94528; and William D. Barton, Panama, Panama (P. O. Box 2723, Balboa, Canal Zone); Filed February 23, 1965; Serial No. 437,345; (Filed under Rule 47(a) and 35 U.S.C. 116); 11 Claims. (Cl. 89–14).

3,344,712; SPRING ACTUATED FEEDING MECHANISM FOR USE WITH PUSHTHROUGH-TYPE CARTRIDGE LINKS; Richard H. Colby, South Hadley, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed September 14, 1961; Serial No. 139,048; 5 Claims. (Cl. 89–33).

October 10, 1967

3,345,770; AUTOMATIC RIFLE FOR FIRING CASELESS AMMUNITION; John J. Scanlon, Jr., Willingboro, N. J., assignor to the United States of America as represented by the Secretary of the Army; Filed October 7, 1966; Serial No. 586,004; 7 Claims. (Cl. 42–18).

3,345,771; HIGH CAPACITY MAGAZINE AND COOPERATING FIREARM STRUCTURE; Stanley D. Silsby, Granby, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed January 7, 1966; Serial No. 519,398; 6 Claims. (Cl. 42–18).

3,345,913; DETENT ASSEMBLY; Floyd J. Milanowski, Stanhope, N. J., assignor to the United States of America as represented by the Secretary of the Army; Filed January 6, 1966; Serial No. 519,167; 3 Claims. (Cl. 89–1).

3,345,914; TWO ROUND BURST MECHANISM MECHANICAL AUTOMATIC RIFLE; Fred N. Newcomb, Kingsville, and Edsel A. Spellman, Abingdon, Md., assignors to the United States of America as represented by the Secretary of the Army; Filed March 31, 1966; Serial No. 540,156; 9 Claims. (Cl. 89–129).

October 17, 1967

3,346,981; BLANK CARTRIDGE PISTOL FOR PROPELLING PROJECTILES; Patrick MacDonald Tabor, Sierra Madre, California, assignor to Mercox, Inc., Pasadena, California, a corporation of California; Filed May 2, 1966; Serial No. 546,979; 5 Claims. (Cl. 42–1).

3,346,982; **BOLT ASSEMBLY FOR SEMI-AUTOMATIC FIREARMS**; Theodor Loffler, Mullheim, Baden, and Gerhard Freudig, Hugelheim uber Mullheim, Baden, Germany, assignors to Rheinmetall G.m.b.H., Dusseldorf, Germany, a Germany company; Filed October 26, 1965; Serial No. 505,263; Claims priority, application Germany, October 29, 1964, R 39,130; 3 Claims. (Cl. 42–16).

3,346,983; **AUTOMATIC CARTRIDGE EJECTOR DEVICE**; Julius E. Brooks, Branford, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed December 21, 1965; Serial No. 515,381; 1 Claim. (Cl. 42–47).

3,346,985; **RECOIL ABSORBING MEANS FOR FIREARMS**; Val A. Browning, Ogden, Utah, assignor to Borwning Industries, Incorporated, Morgan, Utah, a corporation of Utah; Filed September 15, 1966; Serial No. 579,684; 9 Claims. (Cl. 42–74).

October 24, 1967

3,348,327; **TELESCOPICALLY SIGHTED FIRE ARMS**; Martin Lamens, 5811 16 Avenue, R. R. 4, Laduer, British Columbia, Canada; Filed April 11, 1966; Serial No. 541,783; 8 Claims. (Cl. 42–1).

3,348,328; **ADJUSTABLE BUTTSTOCK ASSEMBLY**; Robert Earl Roy, East Haven, Conn., assignor to Colt's Inc., Hartford, Conn., a corporation of Arizona; Filed May 10, 1966; Serial No. 459,005; 9 Claims. (Cl. 42–73).

3,348,451; **GUN TURRETS**; Roy Gilbert Vickers, Grantham, England, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Filed January 25, 1966; Serial No. 522,903; Claims priority, application Great Britain, April 26, 1965, 17,544/65; 10 Claims. (Cl. 89–36).

3,348,452; **MINIATURE ROCKET DEFENSE SYSTEM**; David R. Sawle, Berkeley, Calif., assignor to MB Associates, a corporation of California Filed March 3, 1965; Serial No. 437,350; 3 Claims. (Cl 89–1.807).

3,348,453; **FIREARM WITH FIRING PIN RETARDING MEANS**; Ernst Muhlemann, Zurich, Switzerland, assignor to Oerlikon-Buhrle Holding A.G., Zurich, Switzerland; Filed March 7, 1966; Serial No. 532,384; Claims priority, application Switzerland, March 10, 1965, 3,337/65; 7 Claims. (Cl. 89–180).

November 7, 1967

3,350,807; **METHOD AND MEANS OF IMPROVING FIREARM ACCURACY**; James H. Montoe, 4513 Westchester Drive, Chester, Pa., 19014; Filed May 26, 1966; Serial Number 553,100, 3 Claims. (Cl. 42–75).

November 14, 1967

3,352,016; **DEFENSIVE WEAPON AND CARTRIDGE THEREFORE**; Albert C. Warner and Manton E. Allen, Santa Fe., New Mexico, assignors, by mesne assignments, to Warner Development Limited, Santa Fe, New Mexico, a limited partnership of New Mexico; Filed January 6, 1965; Serial Number 519,040; 16 Claims. (Cl. 42–1).

3,352,047; **GUN TRIGGER LOCKING DEVICE**; Thomas M. McConnell, 2918 Madison Street, Bellwood, Ill., 61104; Filed July 11, 1966; Serial Number 564,056; 2 Claims. (Cl. 42–70).

3,352,206; **GUN CHARGER DEVICE**; Walter S. Draper III, Palmer, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed May 10, 1966; Serial Number 549,424; 5 Claims. (Cl. 89–1).

3,352,207; **GUN POD ENCLOSING A GUN AND A CARTRIDGE TANK CONNECTED BY A CARTRIDGE CHUTE ENCLOSED IN A PYLON CONNECTING THE POD TO AN AIRCRAFT**; Frank William Proudlove, Lytham Saint Anne's, England, assignor to British Aircraft Corporation (Operating) Limited, London, England, a British company; Filed March 28, 1966; Serial Number 538,028; Claims priority, application Great Britain, April 8, 1965; 6 Claims. (Cl. 89–37.5).

November 21, 1967

3,353,291; **RIFLE BARREL ALIGNMENT MECHANISM**; C. Walton Musser, Palos Verdes Estates, California; assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed May 4, 1966; Serial Number 547,676; 10 Claims. (Cl. 42–1).

3,353,446; **EXPULSION APPARATUS**; Charles R. Levesque, Silver Spring, Md., and William M. Mitchell, Akron, Ohio, a corporation of Delaware; Filed January 28, 1966; Serial Number 523,777; 1 Claim. (Cl. 89–1.5).

3,353,447; **DOUBLE-SEAR DEVICE FOR A FORWARD MOVING BARREL MACHINE GUN MOUNTED FOR DIFFERENTIAL RECOIL**; Bengt I. Piskator, Chicopee Falls, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed July 6, 1966; Serial Number 563,654; 4 Claims. (Cl. 89–27).

November 28, 1967

3,354,569; **GUN BORE PROTECTOR**; William T. Kassabian, 5616 Ridgewood Street, Philadelphia, Pa., 19143; Filed September 28, 1965; Serial Number 490,968. 2 Claims. (Cl. 42–1).

3,354,570; **CONCEALED WEAPON**; Angelo J. Rizzo, Jr., 822 Koman Drive, Paramus, N.H., 07652; Substituted for abandoned application; Serial Number 381,333; July 9, 1964; This application March 3, 1966; Serial Number 541,877; 6 Claims. (Cl. 42–1).

3,354,780; **BREECH SEAL FOR FIREARMS UTILIZING CASELESS AMMUNITION**; Marcus Ramsay, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed March 28, 1966; Serial Number 538,078; 5 Claims. (Cl. 89–26).

December 5, 1967

3,355,832; CHARGER GUIDE FOR A BOLT OPERATED FIREARM; Keith Burnham Davis, Ware, and Reginald Herbert Greenhill, Wormley, England, assignors to the Secretary of State for Defence in Her Brittanic Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, London, England; Filed November 9, 1966; Serial Number 593,215; Claims priority, application Great Britain, November 10, 1965; 5 Claims. (Cl. 42–18).

3,355,833; SINGLE SHOT DROP BREECHBLOCK RIFLE; William B. Ruger, Southport, and Lawrence L. Larson, Bethany, Conn.; assignors to Sturm, Ruger & Co., Inc., Southport, Conn.; a corporation of Connecticut; Filed May 16, 1966; Serial Number 550,214; 13 Claims. (Cl. 42–23).

3,355,986; BREECH OBTURATING MEANS FOR GUN WITH TRANSVERSELY SLIDABLE BREECHBLOCK; Giuliano d'Andrea, Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed April 21, 1966; Serial Number 545,518; 8 Claims. (Cl. 89–24).

3,355,987; VIEWING SYSTEM FOR A COMBAT VEHICLE; Herbert Kunze, Kassel, Germany; assignor to Rheinstahl Henschel A.G., Kassel, Germany, a corporation of Germany; Filed March 21, 1966; Serial Number 536,063; Claims priority, application Germany; November 5, 1963; H 50,744; 4 Claims. (Cl. 89–36).

3,355,988; LATERALLY SLIDING BREECHBLOCK FOR LOADING A LARGE CALIBER GUN; Giuliano d'Andrea, Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army, Filed March 3, 1966; Serial Number 533,379; 7 Claims. (Cl. 89–45).

3,355,989; CLOSED BREECH ROCKET GUN; George R. Kruzell, 4301 Hotchkiss, Bay City, Michigan, 48706; Filed October 14, 1965; Serial Number 495,904; 7 Claims. (Cl. 89–187).

December 12, 1967

3,357,306; ACCELERATING PARTICLES TO HIGH VELOCITIES; Charles A. Boyd and Philip G. Luckhardt, West Chester, Pa.; assignors to Aeroprojects Incorporated, West Chester, Pa.; a corporation of Pennsylvania; Filed June 29, 1965; Serial Number 468,006; 5 Claims. (Cl. 89–8).

December 19, 1967

3,358,560; TRIGGER MECHANISM FOR USE WITH AUTOMATIC FIREARMS; Leslie Ernest Ruffell, Dagenham, England, assignor to Sterling Engineering Company, Limited, Dagenham, England; Filed April 29, 1966; Serial Number 546,221; Claims priority, application Great Britain; May 7, 1965; 19,383/65; 4 Claims. (Cl. 89–142).

December 26, 1967

3,359,856; GUN BARREL WITH VARIABLE CAPACITY CHAMBER; Herbert Grosschopf, Neus (Rhine), and Payl Zehfeld, Dusseldorf, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed May 5, 1966; Serial Number 547,863; Claims priority, application Germany, May 15, 1965; R 40,645; 3 Claims. (Cl. 89–16).

3,359,857; FIREARM HAVING A COLLAR FOR CLEANING THE SEAT OF AN INTERNALLY SEALED BREECK BLOCK; William A. Robinson, P.O. Box 252, Towaco, N.J., 07082; Filed May 23, 1967; Serial Number 640,522; 4 Claims. (Cl. 89–25).

3,359,858; AMMUNITION CONTAINER WITH CONVEYOR MEANS FOR THE INTERMITTENT FEEDING OF SETS OF CARTRIDGES; Heinrich Herlack, Zurich, Switzerland, assignor to Oerlikon-Buhrle Holding Ltd., Zurich, Switzerland; Filed July 1, 1966; Serial Number 562,151; Claims priority, application Switzerland, July 2, 1965; 3 Claims. (Cl. 89–34).

3,359,859; AMMUNITION CONTAINER WITH CARTRIDGE LIFT MECHANISM HAVING A CHAIN DRIVE WITH TWO ADJUSTABLE TENSIONING ROLLERS; Heinrich Herlach and Ernst Metzger, Zurich, Switzerland, assingors to Oerlikon-Holding Ltd., Zurich, Switzerland, Filed July 28, 1966; Serial Number 586,429; Claims priority, application Switzerland, July 30, 1965; 3 Claims. (Cl. 89–34).

3,359,860; GAS OPERATED AUTOMATIC FIREARM HAVING A BARREL WITH A GAS CONDUCTING INSERT; Ernst Muhlemann, Zurich, Switzerland, assignor to Oerlikon-Buhrle Holding A.G., Zurich, Switzerland; Filed November 17, 1965; Serial Number 508,229; Claims priority, application Switzerland, November 1964; 4 Claims. (Cl. 89–193).

January 2, 1968

3,360,878; **FIRING MECHANISM FOR BOLT-ACTION FIREARM**; Thomas R. Robinson, Jr., New Haven, Conn.; assignor to The Marlin Firearms Company, New Haven, Conn.; a corporation of Connecticut; Filed September 1, 1966; Serial Number 576,715; 12 Claims. (Cl. 42–16).

3,360,879; **AUTOMATIC SAFETY MECHANISM FOR TRIGGER ASSEMBLIES OF FIREARMS**; Gunther Freitag, Zeller-Mehlis, Germany; assignor to VEB Ernst-Thalmann-Werk Suhl, Suhl, Thuringia, Germany; Filed February 10, 1967; Serial Number 615,114; 6 Claims. (Cl. 42–41).

3,360,880; **SAFETY DEVICE INSERTABLE IN THE CHAMBER OF A FIREARM**; Thomas J. Finnegan, Santa Monica, Calif.; assignor to J.A. Flondella, Maliby, Calif.; Filed April 21, 1966; Serial Number 544,211; 5 Claims. (Cl. 42–66).

January 9, 1968

3,362,095; **CONVERSION OF M1 TYPE FIREARMS TO M14 AMMUNITION**; Jacob Byer, Worcester, Mass.; assignor to Harrington & Richardson, Inc.; Worcester, Mass.; a corporation of Massachusetts; Filed March 7, 1966; Serial Number 535,289; 4 Claims. (Cl. 42–1).

3,362,096; **HAMMER MECHANISM FOR FIREARMS**; Charles Edward Rowe, Jr., Templeton, Mass., (c/o Harrington & Richardson, Inc., Park Ave., Worcester, Mass., 01605); Filed August 24, 1966; Serial Number 574,742; 4 Cliams. (Cl. 42–20).

3,362,291; **SHORT RECOIL BREECH ACTUATING MECHANISM**; Giuliano D'Andrea, Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed September 21, 1966; Serial Number 582,198; 15 Claims. (Cl. 89–24).

3,362,293; **ROUND FEEDING MECHANISM FOR AUTOMATIC GUNS**; Erik Wilhelm Jafvert, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; Filed February 15, 1966; Serial Number 527,592; Claims priority, application Sweden, March 2, 1965; 2,703/65; 7 Claims. (Cl. 89–33).

January 16, 1968

3,363,351; **BOLT ASSEMBLY FOR FIREARM**; Melvin A. Smith, 280 N. Main Street, Wilkes Barre, Pa., 18702; Filed March 30, 1967; Serial Number 626,934; 8 Claims. (Cl. 42–16).

3,363,352; **CUSHIONED FIREARM RECOIL PAD**; Frank A. Pachmayr, 1220 S. Grand Ave.; Los Angeles, Calif, 90015; Filed January 21, 1966; Serial Number 522,167; 5 Claims. (Cl. 42–74).

3,363,509; **RECOIL BOOSTER**; Bruno Tscheepe, Karlsruhe-Durlach, Germany; assignor to Dynamit Nobel Aktiengesellschaft, Troisdorf, Germany; Filed July 7, 1965; Serial Number 470,294; 15 Claims. (Cl. 89–14).

January 23, 1968

3,364,608; **SUBCALIBER RIFLE BARREL WITH SLIDABLE CAP MEMBER FOR HOLDING A SUBCALIBER CARTRIDGE**; Olle Edstrom, Ljusdal, Sweden; assignor to Edstroms Industrier Aktiebolag, Ljusdal, Sweden; a corporation of Sweden, Filed July 16, 1966; Serial Number 558,128; Claims priority, application Sweden, June 22, 1965; 8,268/65; 1 Claim. (Cl. 42–77).

January 30, 1968

3,365,828; **GRENADE LAUNCHER FOR ATTACHMENT TO A RIFLE**; Joseph A. Badall, Branford, and James H. Johnson, New Haven, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed June 25, 1965; Serial Number 46,187; 4 Claims. (Cl. 42–1).

3,365,829; **APPARATUS FOR IMPROVING THE ACCURACY OF A FIREARM**; Richard L. Shockey, 1614 S. Choctaw, El Reno, Okla., 73036; Continuation in part of application Serial Number 435,271; February 25, 1965; This application June 6, 1966; Serial Number 562,044; 6 Claims. (Cl. 42–1).

3,365,830; **GEAR DRIVEN LEVER ACTION FOR FIREARMS**; Edwin S. Vartanian, North Haven, and Viking I. Colliander, Hamden, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed March 1, 1966; Serial Number 530,863; 16 Claims. (Cl. 42–16).

3,365,831; **INTERCHANGEABLE BARREL SHOTGUNS**; Louis V. Wallace, 320 Pueblo Way, Vallejo, Calif., 94590; Filed April 18, 1966; Serial Number 543,196; 4 Claims. (Cl. 42–40).

3,366,009; **RECOILING FIELD GUN MOUNTED ON A CARRIAGE LIFTED OFF WHEELS FOR FIRING**; Henry Wilhelm Aldrin, Bofors, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; Filed January 18, 1966; Serial Number 521,282; Claims priority, application Sweden, January 19, 1965; 686/65; April 1, 1965, 4,197/65; 3 Claims. (Cl. 89–40).

3,366,010; **GUN FIRING MECHANISM**; Richard J. Casull, Salt Lake City, Utah, assignor of one-half to Richard J. Casull and Geraldine Casull, both of Salt Lake City, and one-half to K. R. Eskelsen and Fern P. Eskelsen, both of Sandy, Utah; Original application August 27, 1964; Serial Number 392,540; now Patent Number 3,319,523; dated May 16, 1967; Divided and this application December 2, 1966; Serial Number 618,555; 1 Claim. (Cl. 89–140).

3,366,011; **BUFFER ASSEMBLY HAVING A PLURALITY OF INERTIAL MASSES ACTING IN DELAYED SEQUENCE TO OPPOSE BOLT REBOUND**; Foster E. Sturtevant, West Hartford, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed April 18, 1966; Serial Number 543,242; 8 Claims. (Cl. 89–198).

February 6, 1968

3,367,053; **FIREARM CONSTRUCTION**; Karl R. Lewis, 54 Folly Brook Blvd., Wethersfield, Conn, 06109; Filed June 2, 1965; Serial Nubmer 460,689; 5 Claims. (Cl. 42–59).

3,367,054; **HAND GUARD FOR RIFLES**; Theodor Loffler, Mullhein, Paul Seifried, Badenweller, Gunther Wilmsmeyer, Mullhelm and Karl Harbrecht, Eisental, near Buhl, Germany; assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed February 17, 1966; Serial Nubmer 528,179; Claims priority, application Gernnay, February 19, 1965; R 39,944; 7 Claims. (Cl. 42–71).

3,367,055; **SHOTGUN MUZZLE DEVICE COMPRISING A COMPENSATOR AND CHOKE**; Edward Baden Powell, 250 N. Orange Grove Ave., Pasadena, Calif., 91103; Filed December 27, 1965; Serial Number 516,632; 14 Claims. (Cl. 42–79).

3,367,236; **ROTARY AMMUNITION BELT FEEDER HAVING A PLURALITY OF BELT FEED APERTURES**; Hartmut Menneking, Dusseldorf, Germany; assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed May 16, 1966; Serial Number 550,479; Claims priority, application Germany, May 18, 1965; R 40,658; 4 Claims. (Cl. 89–33).

February 13, 1968

3,368,297; **GUN SAFETY LOCKING ROD**; Morgan E. Lentz, 60 Addison Avenue, Rutherford, N.J., 07070; Filed March 23, 1966; Serial Number 536,720; 8 Claims. (Cl. 42–1).

3,368,298; **BREECH BOLT CARRIER ASSEMBLY AND SLIDE COVER THEREFOR**; Bruce W. Browning, Ogden, Utah, assignor to Browning Industries, Inc., Morgan, Utah, a corporation of Utah; Filed January 3, 1967; Serial Number 606,846; 8 Claims. (Cl. 42–16).

3,368,450; **BREECH MECHANISM FOR A RECOILLESS GUN**; Francis W. Dietsch, Levittown, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed October 20, 1965; Serial Number 588,691; 12 Claims. (Cl. 89–1.705).

3,368,453; **MUZZLE BRAKE**; John J. Shaw, 310 NE D St., Grants Pass, Oregon, 97526; Filed March 24, 1966; Serial Number 537,191; 5 Claims. (Cl. 89–14).

3,368,454; **ACCESSORY MOUNTING MEANS**; John P. Peck, Fountain Valley, and C. Walton Musser, Palos Verdes Estates, Calif.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed September 22, 1966; Serial Number 582,205; 7 Claims. (Cl. 89–14).

February 20, 1968

3,369,314; **FIREARM HAVING A REVOLVING CYLINDER WITH AN OPERATING ROD ATTACHED THERETO**; Marcus Ramsay, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed July 15, 1966; Serial Number 562,705; 14 Claims. (Cl. 42–39.5).

3,369,316; **APPARATUS FOR MOUNTING AND LOCKING A FOLDING STOCK ON A RIFLE**; Arthur Miller, Costa Mesa, Calif.; assignor to Armaline, Inc., Costa Mesa, Calif.; a corporation of California; Filed April 29, 1966; Serial Number 546,386; 5 Claims. (Cl. 42–72).

3,369,453; **RECOIL BOOSTER FOR FULLY AUTOMATIC, SEMI-AUTOMATIC AND/OR SINGLE-SHOT FIRING WEAPONS**; Hartmut Menneking and Hermann Henning, Dusseldorf, Germany; assignors to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed December 19, 1964; R 39,565; 3 Claims. (Cl. 89–14).

3,369,454; **DEVICE FOR FEEDING CARTRIDGES DEPOSITED IN A TWIN CARTRIDGE MAGAZINE OF A GUN**; Arent Gustav Carlsson, Karlskoga, Sweden; assignor to Aktiebolaget Bofors, Bofors, Sweden; a company of Sweden; Filed April 28, 1966; Serial Numver 546,034; Claims priority, application Sweden, May 6, 1965; 6 Claims. (Cl. 89–33).

3,369,455; **GUN-LAUNCHED VEHICLES**; John W. Jones, Redlands, Calif.; assignor to Lockheed Aircraft Corporation, Burbank, Calif.; Filed February 25, 1965; Serial Number 435,184; 3 Claims. (Cl. 89–1.818).

February 27, 1968

3,370,372; **BOLT ASSEMBLY FOR FIREARMS**; Vern C. Thompson, R.R. 3, Mora, Minn., 55051; Filed August 22, 1966; Serial Number 574,154; 5 Claims. (Cl. 42–16).

3,370,374; **FIRING MECHANISM WITH MEANS FOR ADJUSTING TRIGGER-SEAR OVERLAP**; Sven Gunnar Olof Larsson, Huskvarna, Sweden; assignor to Husqvarna Vapenfabriks Aketibolag, Huskvarna, Sweden; Filed January 24, 1966; Serial Number 522,498; Claims priority, application Sweden, January 27, 1965; 1,039/65); 5 Claims. (Cl. 42–69).

3,370,506; **AMMUNITION FEEDER AND BOOSTER**; Samuel Altschuler, Skokie, and Robert F. Windstrup, Chicago, Ill.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed October 13, 1966; Serial Number 540,360; 1 Claim. (Cl. 89–33).

3,370,507; **STRUCTURE FOR SEALING A GUN SHIELD IN A GUN TURRET**; Karl Fammler, Dusseldorf, and Gustav Domke, Ratingen, Germany; assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed March 9, 1966; Serial Number 533,058; Claims priority, application Germany, March 11, 1965; R 40,066; 2 Claims. (Cl. 89–36).

March 5, 1968

3,371,440; **ADJUSTABLE MAGAZINE PLUG**; Charles Cassell, 2708 SW 44th St., Oklahoma City, Okla, 73119; Filed March 24, 1967; Serial Number 625,848; 5 Claims. (Cl. 42–49).

3,371,441; **SAFETY MECHANISM FOR HAND FIREARMS**; Fritz Walther, 4 Wettersteinweg, 79 Ulm (Danube), Germany; Filed February 18, 1966; Serial Number 528,636; Claims priority application Germany, February 25, 1965; W 38,632; 6 Claims. (Cl. 42–70).

3,371,442; **DAMPED SPRING MEANS**; Robert L. Carlson, Chicago, Ill.; assignor to W. H. Miner, Inc.; Chicago, Ill.; a corporation of Delaware; Filed March 24, 1966; Serial Number 537,206; 3 Claims. (Cl. 42–74).

March 12, 1968

3,372,506; **MAGAZINE CATCH FOR FIREARMS**; Cary Wilhelm, Hamden, Conn.; assignor to The High Standard Manufacturing Corporation, Hamden, Conn.; a corporation of Connecticut; Filed May 13, 1966; Serial Number 549,931; 8 Claims. (Cl. 42–7).

March 19, 1968

3,373,519; **CARRIER LATCH RETAINER FOR AUTOLOADING FIREARMS**; Walter L. Dahl, Herkimer, and James S. Martin, Mohawk, N.Y.; assignors to Remington Arms Company, Inc., Bridgeport, Conn.; a corporation of Delaware, Filed April 3, 1967; Serial Number 627,785; 7 Claims. (Cl. 42–17).

3,373,520; **AMMUNITION PACKAGE AND MAGAZINE**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed February 23, 1967; Serial Number 618,094; 4 Claims. (Cl. 42–49).

3,373,521; **CARTRIDGE MAGAZINE**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed September 16, 1966; Serial Number 580,093; 11 Claims. (Cl. 42–50).

March 26, 1968

3,374,708; **ELECTRICAL ANTI-PERSONNEL WEAPON**; George A. Wall, North Carver, Mass.; Eileen T. Wall, executrix of said George A. Wall, deceased; assignor to Eileen T. Wall, North Carver, Mass.; Filed January 26, 1965; Serial Number 428,096; 11 Claims. (Cl. 89–1).

April 9, 1968

3,376,783; **ROTARY ACTUATOR**; Charles R. Olsen, Los Angeles, Calif., (5409 Cromer Place, Woodland Hill, Calif., 91364); Filed April 11, 1966; Serial Number 541,729; 10 Claims. (Cl. 89–1).

3,376,784; **SPACING MEMBER FOR A RECOIL-FREE WEAPON**; Hugo Abramson, Eskilstuna, Sweden; assignor to Forsvarets Fabriksverk, Eskilstuna, Sweden; a corporation of Sweden; Filed May 19, 1966; Serial Number 551,342; Claims priority, application Sweden, July 5, 1965; 8,836/65; 5 Claims. (Cl. 89–1.703).

April 16, 1968

3,377,730; **BOLT MECHANISM FOR BOLT ACTION TYPE FIREARM AND MECHANISM USED THEREIN FOR CONVERTING ROTARY MOTION TO RECIPROCATING AND ROTARY MOTION**; Karl R. Lewis, 77 Olney Road, Wethersfield, Conn., 06109; Continuation in part of application Serial Number 524,763; February 3, 1966. This application December 16, 1966; Serial Number 609,979; 35 Claims. (Cl. 42–16).

3,377,731; **LEVER ACTION TRIGGER SYSTEM**; John S. Lawrence, Ogden, Utah; assignor to Browning Industries, Inc., Mountain Green, Utah; Filed March 14, 1966; Serial Number 534,115; 9 Claims. (Cl. 42–20).

3,377,732; **LOADING MAGAZINE FOR REVOLVER CYLINDER**; Norman A. Bivens, 10664 Wheatland Avenue, Sunland, Calif., 91040; Filed August 5, 1966; Serial Number 570,525; 8 Claims. (Cl. 42–50).

3,377,918; **SPLIT RING VALVE FOR BORE EVACUATOR**; Walter H. Austin, Jr., and Donald F. Trudeau, Troy, N.Y.; assignors to the United States of America as represented by the Secretary of the Army; Filed April 21, 1966; Serial Number 545,536; 8 Claims. (Cl. 89–1).

3,377,919; **AMMUNITION LINK**; Burton P. Clark, Fayetteville, Tennessee; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed September 22, 1966; Serial Number 582,203; 6 Claims. (Cl. 89–35).

April 23, 1968

3,378,943; **SAFETY PLUG FOR GUNS**; Raymond Valburg, 797 Schroeder Lane, Grants Pass, Oregon, 97526; Filed October 18, 1966, Serial Number 587,560; 6 Claims. (Cl. 42–1).

3,378,944; **FLARE LAUNCHING DEVICE**; Robert Mainhardt, Callearroyo Diablo, and Edward F. Lamp, Walnut Creek, Calif.; assignors to MB Associates, a corporation of California; Filed November 15, 1966; Serial Number 594,504; 6 Claims. (Cl. 42–1).

3,379,098; **MOUNTING DEVICE FOR AUTOMATIC GUNS**; Louis Zurbuchen, Zurich, Switzerland; assignor to Oerlikon Buhrle Holding Ltd., Zurichx Switzerland; Filed July 29, 1966; Serial Number 568,853; Claims priority, application Switzerland, August 5, 1965; 11,032/65; 9 Claims. (Cl. 89–40).

April 30, 1968

3,380,182; **RECEIVER STOCK ASSEMBLY FOR FIREARM**; Bruce W. Browning, Ogden, Utah; assignor to Browning Industries, Incorporated, Morgan, Utah; a corporation of Utah; Filed January 3, 1967; Serial Number 606,844; 7 Claims. (Cl. 42–75).

3,380,183; **UPPER HANDGUARD FIXEDLY MOUNTED ON BARREL ASSEMBLY BY BREECHBLOCK GUIDE RODS**; Arthur Miller, Costa Mesa, Charles H. Dorchester, Newport Beach, and George C. Sullivan, North Hollywood, Calif.; assignors to Armalite, Inc., Costa Mesa, Calif.; a corporation of California; Continuation in part of application Serial Number 432,198; February 12, 1965; now Patent Number 3,318,192; dated May 9, 1967; This applicaiton March 20, 1967; Serial Number 622,340; 3 Claims. (Cl. 42–75).

3,380,340; **RECOIL FREE WEAPON**; Johan Erik Herman Bergman, Hagersten, and Nils Edward Haglund, Eskilstuna, Sweden; a corporation of Sweden; Filed May 19, 1966; Serial Number 551,344; Claims priority, application Sweden, June 22, 1965; 8,224/65; 9 Claims. (Cl. 89–1.703).

3,380,341; **SAFING MEANS FOR HIGH RATE OF FIRE MULTI-BARREL AUTOMATIC WEAPON**; Robert E. Chiabrandy, Burlington, Vt.; assignor to General Electric Company, New York, N.Y.; a corporation of New York; Filed December 21, 1966; Serial Number 603,573; 5 Claims. (Cl. 89–12).

3,380,342; **CLEARING MECHANISM FOR HIGH RATE OF FIRE MULTI-BARREL AUTOMATIC WEAPON**; Robert E. Chiabrandy, Burlington, Vt.; a corporation of New York; Filed December 21, 1966; Serial Number 603,574; 6 Claims. (Cl. 89–12).

3,380,343; **FIRING MECHANISM FOR HIGH RATE OF FIRE MULTI-BARREL AUTOMATIC WEAPON**; Robert E. Chiabrandy, Burlington, and Douglas P. Tassie, St. George, Vermont; assigners to General Electric Company, a corporation of New York; Filed December 21, 1966; Serial Number 603,645; 12 Claims. (Cl. 89–12).

3,380,344; **PRESSURE CONTROL DEVICE**; Ludwig Bucklisch, Haendorf, and Ludger Volpert, Spich, Germany; assignors to Dynamit Nobel Aktiengesellschaft, Troisdorf, Germany; Original application October 1, 1964; Serial Number 400,745; now Patent Number 3,307,451; dated March 7, 1967; Divided and this application January 3, 1967; Serial Number 630,162; Claims priority, application Germany, October 2, 1963; D 42,510; 9 Claims. (Cl. 89–14).

3,380,345; **ENGINE WEAPONS**; Daniel Emmet Nelson, Aptos, Calif.; assignor to General Kinetics Corporation, Monterey, Calif.; a corporation of California; Filed October 19, 1965; Serial Number 587,757; 4 Claims. (Cl. 89–7).

3,380,346; **APPARATUS FOR IMPROVING ACCURACY OF SEMI-AUTOMATIC FIREARMS**; Cassius P. Gustin, 1729 Ohio Avenue, Modesto, Calif., 95351; Filed June 23, 1966; Serial Number 559,855; 6 Claims. (Cl. 89–196).

May 7, 1968

3,381,403; **MEANS FOR USE IN THE ADMINISTERING OF DRUGS, MEDICINES AND THE LIKE TO ANIMALS**; Colin Albert Murdoch, 14A Hassal St., Timary, South Island, New Zealand; Continuation in part of application Serial Number 238,417, November 19, 1962. This application April 7, 1966, Serial Number 540,953; Claims priority, application New Zealand, November 24, 1961, 130,784; August 13, 1962, 132,777; 10 Claims. (Cl. 42-1).

3,381,404; **SPRING URGED RATCHET ADVANCE ELEMENT FOR REVOLVERS**; William T. Quinn, 681 Park Avenue, Freehold, N.J., 07728; Filed October 12, 1965; Serial Number 508,644; 4 Claims. (Cl. 42–59).

3,381,405; **FIREARM RECOIL REDUCER**; Jesse R. Edwards, 259 Herbert Street, Alton, Ill., 62002; Continuation in part of application Serial Number 454,435; May 10, 1965; This application September 22, 1966, Serial Number 581,203; 7 Claims. (Cl. 42–74).

3,381,406; **PORTABLE GUN REST UTILIZING A FLEXIBLE STRAP**; Willard C. Ormond, Route 2, Box 70-A, Rigby, Idaho, 83442; Filed January 17, 1967; Serial Number 609,926; 5 Claims. (Cl. 42--94).

May 14, 1968

3,382,596; **SAFETY PLUG FOR FIREARM CHAMBER**; Clyde R. Rockwood, 2708 Highland Court, St. Joseph, Mich., 49085; Filed October 27, 1966; Serial Number 589,940; 12 Claims. (Cl. 42–1).

3,382,597; **SINGLE SHOT DROP BREECHBLOCK RIFLE**; William B. Ruger, Southport, and Lawrence L. Larson, Bethany, Conn.; assignors to Sturm, Ruger & Co., Inc., Southport, Conn.; a corporation of Connecticut; Continuation in part of application Serial Number 550,214; May 16, 1966; This application May 16, 1967; Serial Number 638,942; 3 Claims. (Cl. 42–23).

3,382,765; **MULTIPLE DRUM-TYPE MAGAZINE OF PARTICULAR UTILITY WITH ROCKET-BOOSTED AMMUNITION AND FEATURING RADIALLY INWARD HELICAL FEED TOWARD A COMMON RECIPROCAL FEED SLIDE**; Kenneth J.J. McGowan, Richmond, Ind.; assignor to Avco Corporation, Richmond, Ind.; a corporation of Delaware; Application November 1, 1966, Serial Number 591,288, now Patent No. 3,331,282, dated July 18, 1967, which is a division of application Serial Number 478,570, August 10, 1965, now Patent Number 3,315,567, dated April 25, 1967. Divided and this application March 29, 1967; Serial Number 626,816; 2 Claims. (Cl. 89–34).

3,382,766; **COMBINATION MANUAL AND AUTOMATIC BOLT ACTION FOR FIREARMS**; Abe Seiderman, Coral Gables, Fla.; assignor to Universal Firearms Corporation, Hialeah, Florida; a corporation of Florida; Filed September 30, 1966; Serial Number 583,266; 3 Claims. (Cl. 89–193).

May 21, 1968

3,383,790; **PLASTIC BOX MAGAZINE WITH A TOP METALLIC CLAMPING MEMBER**; Henry A. Into, Wallingford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed May 16, 1967; Serial Number 638,832; 8 Claims. (Cl. 42–50).

3,383,984; COMPACT CONSTANT PRESSURE LUBRICATOR FOR THE 20 MM HS 820 GUN SYSTEM; Giuliano D'Andrea, Troy, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed December 14, 1966; Serial Number 601,813; 8 Claims. (Cl. 89–1).

3,383,985; POSITIVE INTERLOCKING SAFETY SWITCH; Richard H. Field, Broomall, Charles T. Davey, Dresher, and Raymond C. Amicone, Springfleid, Pa.; assingors by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed July 31, 1967; Serial Number 657,745; 9 Claims. (Cl. 89–1).

3,383,986; ROTATING GUN MOUNT WITH RECIRCULATING BALL BEARING MEANS; Richard Frank Leopole, South Burlington, Eugene Ashley, Burlington, and Donald Henry Spawn, South Burlington, Vt.; assignors to General Electric Company; a corporation of New York. Filed December 30, 1966; Serial Number 606,211; 6 Claims. (Cl. 89–37.5).

3,383,987; MULTIPLE-SCALE RETICLE FOR A FIRE CONTROL SYSTEM WITH MEANS FOR ADJUSTING THE SERVOSYSTEM TO A SELECTED ONE OF THE SCALES; Lester S. MacMillan, Springfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 27, 1967; Serial Number 626,668; 4 Claims. (Cl. 89–41).

May 28, 1968

3,384,988; ACCURACY SHOE FOR A PISTOL; Urvano A. Salaiz, 4295 Tehama Avenue., Fremont, Calif., 94538; Filed February 9, 1967; Serial Number 614,971; 2 Claims. (Cl. 42–71).

3,384,989; SHOTGUN BORE REDUCER; Thurman R. Thomas, 421 Wright Street, High Point, N.C., 27260; Filed July 21, 1966; Serial Number 568,823; 2 Claims. (Cl. 42–77).

3,385,163; LAUNCHER FOR FLARE AND SMOKE SIGNALS; Nicholas Kotikov, 3132 Unruh Ave., Philadelphia, Pa., 19149; Field October 20, 1967; Serial Number 676,879. 7 Claims. (Cl. 89–1).

3,385,164; SILENCER FOR SMALL ARMS; Karl-Heinz Walther, Ulm (Danube), and Siegfried F. Hubner, Stuttgart-Heumaden, Germany; assignors to Carl Walther, Ulm, (Danube), Germany; Filed May 6, 1966; Serial Number 548,203; Claims priority, application Germany, May 14, 1965; W 39,154; 2 Claims. (Cl. 89–14).

3,385,165; CRADLE MOUNTINGS FOR GUNS IN ARMORED TURRETS; Otto Hildebrandt, Dusseldorf, and Franz Horn, Osterath (Lower Rhine), Germany; assignors to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed June 30, 1966; Serial Number 561,928; Claims priority application Germany, July 3, 1965; R 41,013; 8 Claims. (Cl. 89–37).

June 4, 1968

3,386,335; GUN PLATFORM STABILIZATION SYSTEM; Frank S. Preston, Fairfield, Conn.; assignor to United Aircraft Corporation, East Hartford, Conn.; a corporation of Delaware; Filed June 8, 1967; Serial Number 644,628; 15 Claims. (Cl. 89–41).

3,386,336; CONVERTIBLE MACHINE GUN FOR RIGHT- AND LEFT–HAND CARTRIDGE FEED AND OPERATION; Robert E. Roy, East Haven, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed March 30, 1966; Serial Number 538,701; 12 Claims. (Cl. 89–191).

June 11, 1968

3,387,398; CARTRIDGE FEED IN LEVER-OPERATED RIFLE; Karl Arndt, Lauf, near Nurnberg, Germany; Filed March 4, 1966; Serial Number 531,950; Claims priority, application Germany, March 4, 1965; R 40,039; 1 Claim. (Cl. 42–17).

3,387,399; REVOLVER LATCH MECHANISM; Douglas S. McClenahan. 900 Mill Hill Road, Southport, Conn., 06940; Filed April 25, 1966; Serial Number 544,917; 4 Claims. (Cl. 42–52).

3,387,400; AUTOMATIC SAFETY DEVICE WITH MANUAL RELEASE FOR BOLT ACTION FIREARMS; Joseph A. Badali, Branford, Victor Alexander Kulikowski, Hamden, and Edwin S. Vartanian, North Haven, Conn.; assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed May 8, 1967; Serial Number 636,737; 3 Claims. (Cl. 42–70).

3,387,538; BARREL RECOIL STRUCTURE FOR FIREARMS; Val A. Browning, Ogden, Utah; assignor to Browning Industries, Incorporated, Ogden, Utah; a corporation of Utah; Filed September 19, 1966; Serial Number 580,459; 6 Claims. (Cl. 89–177).

June 18, 1968

3,388,494; GUNSTOCK OF TWO SECTIONS PIVOTAL RELATIVE TO EACH OTHER; John W. Kinball, 1216 Garden Road, Milford, Mich, 48042; Filed March 25, 1966; Serial Number 537,353; 19 Claims. (Cl. 42–74).

3,388,633; MULTI-STAGED BALLISTIC DEVICE; Howard A. Kirschner, Levittown, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 1, 1967, Serial Number 613,978; 6 Claims. (Cl. 89–8).

June 25, 1968

3,389,487; AUTOMATIC SHOTGUN; Giovanni Benelli, Pesaro, Italy; assignor to S.A.S.F. III Benelli G.F. & C., Pesaro, Italy, a corporation of Italy; Filed May 26, 1966; Serial Number 553,168; Claims priority; application Italy, August 6, 1965; 17,802/65; 1 Claim. (Cl. 42–17).

3,389,488; SINGLE-TRIGGER RELEASE MECHANISM FOR A DOUBLE-BARRELED SHOTGUN; Carlo Pietro Beretta, Gardone Val Trompia, Brescia, Italy; assignor to Fabbrica Darmi Pietro Beterra S.p.A., Gardone Val Trompia, Brescia, Italy; Filed February 28, 1967; Serial Number 619,456; Claims priority, application Italy, March 3, 1966; 15,157; 2 Claims. (Cl. 42–42).

July 2, 1968

3,390,475; **MAGAZINE HAVING A MOVABLE DOOR HINGED THERETO**; Joseph A. Badali, Branford, and James H. Johnson, New Haven, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Original application June 25, 1965; Serial Number 468,187; now Patent Number 3,365,828, dated January 30, 1968; Divided and this application December 28, 1966; Serial Number 618,560; 1 Claim. (Cl. 42–49).

3,390,476; **FIREARM**; Ernest Henri Joseph Vervier, 324 Rue du Roi Albert, Oupeye, Belgium; Filed September 8, 1966; Serial Number 578,014; Claims priority; application Belgium, October 5, 1965; 40,657; Patent 670,534; 3 Claims. (Cl. 42–50).

3,390,477; **SUPPORTING DEVICE FOR SIGHTING FIREARMS**; Jack O. Galbraith, 162 W. Main St., Lewisville, Texas, 75067; Filed May 25, 1966; Serial Number 552,931; 2 Claims. (Cl. 42–94).

3,390,609; **FIRING MECHANISM FOR CANNONS**; Herman J. Reepmeyer, Cohoes, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed August 23, 1966; Serial Number 574,874; 2 Claims. (Cl. 89–27).

3,390,610; **EJECTOR PORT RESTRICTOR**; Coy C. Jordan, 1309 Williamson Drive, Raleigh, N.C., 27608; Filed November 9, 1966; Serial Number 593,178; 3 Claims. (Cl. 89–33).

July 9, 1968

3,391,602; **FREQUENCY RESPONSIVE LUBRICATION SYSTEM**; George Dewey Brooks, South Burlington, and Dale Andrew Farrington, Winooski, Vt., and John Emmet Folwy, Longmeadow, Mass.; assignors to General Electric Company; a corporation of New York, Filed July 10, 1967; Serial Number 652,308; 4 Claims. (Cl. 89–1).

July 16, 1968

3,392,469; **METHOD OF OPERATING A REVOLVER FOR SHOOTING A PROJECTILE ATTACHED ON THE OUTSIDE OF THE BARREL THEREOF**; Uberto Dubini, Via Marco d'Oggiono 35, Lecco, Como, Italy; Field June 6, 1966; Serial Number 555,318; Claims priority application Italy, June 9, 1965; Patent 767,778; 2 Claims. (Cl. 42–1).

3,392,470; **SLIDABLE BARREL FIREARM WITH SAFETY PREVENTING OPENING OF THE FIREARM WHILE COCKED**; James Kevin Patrick Vincent Colombus Kavanagh, Hanover House, Hanover Street, Cheltenham, Gloucestershire, England; Filed November 25, 1966; Serial Number 597,028; Claims priority, application Great Britain, November 26, 1965; 50,296/65; 7 Claims. (Cl. 42–10).

3,392,471; **ADJUSTABLE TRIGGER LOCKS FOR FIREARMS**; Daniel J. Foote, Wauwatosa, Wis.; assignor to Master Lock Company, Milwaukee, Wis.; a corporation of Wisconsin; Filed April 21, 1967; Serial Number 632,721; 4 Claims. (Cl. 42–70).

3,392,472; **SABOT REMOVER WITH HELICALLY ARRANGED RIDGES**; Irwin R. Carr, Lutherville, Md., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed June 30, 1967; Serial Number 651,106; 2 Claims. (Cl. 42–76).

3,392,628; **BALLISTICALLY ACTUATED DETONATING DEVICE FOR AN EXPLOSIVE CHARGE**; Robert J. Armantrout, Lake Forest, N.J.; assignor to Hercules Incorporated, Wilmington, Del., a corporation of Delaware; Filed September 12, 1966; Serial Number 578,658; 4 Claims. (Cl. 89–1).

July 23, 1968

3,393,605; **EXPLOSIVELY ACTUATED DEVICE FOR HIGH PRESSURE ENVIRONMENT**; Paul E. Parnell, 3215 Boundary Street, San Diego, Calif., 92104; Filed August 31, 1967; Serial Number 665,683; 11 Claims. (Cl. 89–1).

July 30, 1968

3,394,481; **ADAPTER FOR CONVERTING A SINGLE SHOT FIREARM INTO A TWO-SHOT REPEATER**; Hector Mendoza Orozco, Bartolache 1914, Mexico City, Mexico; Filed August 29, 1966; Serial Number 575,805; Claims priority application Mexico, April 30, 1966; 88,544; 3 Claims. (Cl. 42–17).

3,394,482; **COMBINED EJECTOR AND BOLT STOP**; Joseph A. Badali, Branford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed February 28, 1967; Serial Number 619,332; 2 Claims. (Cl. 42–25).

August 6, 1968

3,395,478; **RIFLE MOUNTED AUXILIARY FIREARM AND MULTIPROJECTILE CARTRIDGE THEREFOR**; Earle M. Harvey, Agawam, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 2, 1962; Serial Number 177,707; 5 Claims. (Cl. 42–1).

3,395,479; **AMMUNITION MAGAZINE WITH REMOVABLE FOLLOWER**; George E. Collins, Route 1, Wyoming, Minn, 55092; Filed December 22, 1966; Serial Number 603,822; 10 Claims. (Cl. 42–50).

3,395,613; **TRIGGER MECHANISM FOR FIREARMS**; Bruce W. Browning, Ogden, Utah; assignor to Browning Industries, Incorporated, Morgan County, Utah; a corporation of Utah; Filed January 3, 1967; Serial Number 606,845; 1 Claim. (Cl. 89–146).

August 13, 1968

3,396,630; STABILIZER; Helmut Hinterthur, Hamburg-Blankenese, and Wolfgang Pestel, Hamburg, Germany; assignors to Licentia Patent-Verwaltungs-G.m.b.H.; Frankfurt am Main, Germany; Filed May 25, 1966; Serial Number 561,304; (Filed under Rule 47(a) and 35 USC 116). 6 Claims. (Cl. 89–41).

August 20, 1968

3,397,473; CARTRIDGE EXTRACTOR AND EXTRACTOR SPRING THEREFOR; Bruce W. Browning, Ogden, Utah; assignor to Browning Industries, Incorporated, Morgan, Utah; a corporation of Utah; Original application January 3, 1967; Serial Number 606,846; now Patent Number 3,368,398; dated February 13, 1968. Divided and this application December 26, 1967, Serial Number 693,600; 5 Claims. (Cl. 42–25).

3,397,474; TRIGGER, SEAR, SAFETY ASSEMBLY; Joseph A. Badali, Branford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed June 14, 1967; Serial Number 646,094; 3 Claims. (Cl. 42–70).

3,397,475; GRIP PLATES FOR A REVOLVER HANDLE; Edward M. Mikus, 17680 Dwyer St., Detroit, Michigan, 48212; Filed March 3, 1967; Serial Number 620,356; 4 Claims. (Cl. 42–71).

August 27, 1968

3,398,476; FIREARM WITH A BREECH BOLT HAVING A SWINGABLE ACTION END WITH AN EXTRACTOR ATTACHED THERETO; Tore Erik Hoving, Storgrogatan 13, Filipstad, Sweden; Filed October 20, 1966; Serial Number 558,173; 9 Claims. (Cl. 42–25).

September 3, 1968

3,399,479; ACTION FOR FIREARM USING A CASELESS ROUND; Bernard Goldstein, Landing, N.J.; assignor of five percent each to Max Greenberg, West Orange, Paual H. Goldstein, Union, and Herbert Greenberg, Elizabeth, N.J.; Filed May 11, 1967; Serial Number 637,753; 7 Claims. (Cl. 42–9).

3,399,480; PLASTIC MAGAZINE FOR CARTRIDGES FOR FIREARMS; Charles Edward Rowe, Jr., Templeton, Mass., (c/o Harrington & Richardson, Inc., Park Ave., Worcester, Mass., 01603); Filed August 24, 1966; Serial Number 574,741; 1 Claim. (Cl. 42–50).

3,399,481; DETACHABLE CHARGER FOR AUTOMATIC SHOTGUNS; Pietro Georgini, Via Roma 24, Montignoso, Massa Carrara, Italy; Filed May 1, 1967; Serial Number 635,042; Claims priority, application Italy, June 3, 1966; 12,971/66; 4 Claims. (Cl. 42–87).

3,399,596; AIR OPERATED PROJECTILE FIRING APPARATUS; Ronald W. Joyce, Springdale, Eugene E. Billingslea, Rogers, Leopold C. Sage, Fayetteville, and Robert K. Marshall, Rogers, Ark,; assignors, by mesne assignments, to Victor Comptometer Corporation, Chicago, Ill.; a corporation of Illinois; Filed November 30, 1966; Serial Number 598,087; 13 Claims. (Cl. 89–7).

3,399,597; SILENT FIREARM; Walter F. Perrine, Phoenix, Ariz.; assignor to Tonalea Enterprises, Inc.; a corporation of Arizona; Filed December 10, 1965; Serial Number 513,051; 2 Claims. (Cl. 89–14).

3,399,598; FIREARM BARREL COMPRISING A BREECH-BLOCK DISPLACEABLE TRANSVERSELY TO THE BORE AXIS; Josef Hornfeck, Dusseldorf, and Rolf Bartolles, Wuppertal-Vohwinkel, Germany; assignors to Rheinmetall G.m.b.H.; Dusseldorf, Germany; a German company; Filed October 25, 1966; Serial Number 589,236; 1 Claim. (Cl. 89–24).

September 17, 1968

3,401,598; GUN MOUNTING FOR ARMED VEHICLES; Charles C. Sons, Jr., Peoria, Ill.; assignor to Caterpillar Tractor Co., Peoria, Ill.; a corporation of California; Filed September 6, 1966; Serial Number 577,522; 2 Claims. (Cl. 89–40).

3,401,599; STABILIZER; Armin Schonherr, Hamburg-Niendorf, and Wolfgang Pestel, Hamburg, Germany; assignors to Licentia Patent-Verwaltungs, G.m.b.H.; Frankfurt am Main, Germany; Filed May 25, 1966; Serial Number 561,305; 8 Claims. (Cl. 89–41).

September 24, 1968

3,402,498; MULTIPLE BARREL FIREARM WITH AUTOMATIC HAMMER SAFETY MECHANISM; Gunther Freitag, Zella-Mehlis, and Dieter Schubel, Vesser, Germany; assignors to VEB Ernst-Thalmann-Werk Suhl, Suhl, Thuringia, Germany; Filed June 22, 1967; Serial Number 648,092; 5 Claims. (Cl. 42–41).

3,402,499; GUNSTOCK WITH ITS BUTT PORTION LATERALLY OFFSET FROM THE BARREL AXIS; Louis A. Florek, 1054 23rd Ave., SE., Minneapolis, Minn, 55414; Filed June 14, 1967; Serial Number 646,044; 1 Claim. (Cl. 42–71).

October 1, 1968

3,403,596; OBTURATOR ARRANGEMENT FOR GUN BARRELS; Erich Bartels, Ratingen, Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed June 29, 1966; Serial Number 561,590; Claims priority, application Germany, July 21, 1965; R 41,140; 2 Claims. (Cl. 89–26).

October 8, 1968

3,404,477; **SEMIAUTOMATIC GRENADE LAUNCHER**; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America, as represented by the Secretary of the Army; Filed May 23, 1961; Serial Number 112,123; 6 Claims. (Cl. 42--1).

3,404,478; **SEMIAUTOMATIC GRENADE LAUNCHER**; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 23, 1961; Serial Number 112,125; 9 Claims. (Cl. 42–1).

3,404,479; **SEMIAUTOMATIC GRENADE LAUNCHER**; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed November 15, 1961; Serial Number 153,259; 15 Claims. (Cl. 42--1).

3,404,480; **BREECH BOLT ASSEMBLIES FOR FIREARMS**; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia, assignors to Zavody Jana Svermy, narodni podnik, Brno, Czechoslovakia; a corporation; Filed May 23, 1967; Serial Number 640,668; Claims priority, application Czechoslovakia; May 24, 1966; 3,435/66; 6 Claims. (Cl. 42–16).

3,404,598; **CUP-SEALED ACTUATOR WITH OBTURATING GROOVE ANCHORING AND SEALING ARRANGEMENT**; Mitchell G. Angelos, Cockeysville, Md.; assignor to AAI Corporation, Cockeysville, Md.; a corporation of Maryland; Filed December 30, 1966; Serial Number 606,070; 2 Claims. (Cl. 83–1).

3,404,599; **APPARATUS AND METHOD FOR PRODUCING A HIGH VELOCITY BEAM OF GAS MODULES AND THE LIKE**; Martin Annis, Newtonville, Mass.; assignor to American Science and Engineering, Inc., Cambridge, Mass.; a corporation of Massachusetts; Filed August 31, 1966; Serial Number 576,465; 24 Claims. (Cl. 89--1).

3,404,600; **EXPLOSIVE PROJECTOR FOR PROJECTILES**; Andrew G. Bilek, Valparaiso, Fla.; assignor to the United States of America as represented by the Secretary of the Air Force; Filed September 20, 1966; Serial Number 581,141; 2 Claims. (Cl. 89–8).

October 15, 1968

3,405,469; **COLUMN-MOUNTED PORTABLE FIREARM FOR A PROJECTILE**; Marcel Francois, Chatenay-Malabry, France; assignor to Compagnie Francaise Thomson Houston-Hotchkiss Brandt, Paris, France; a French body corporate; Filed December 9, 1966; Serial Number 600,414; Claims priority, application France, December 15, 1965; 42,325; 5 Claims. (Cl. 42–1).

3,405,470; **PNEUMATIC RECOIL BUFFER ATTACHMENT FOR A FIREARM**; Fred Wesemann, P.O. Box 1066, Sterling, Colorado, 80751; Filed August 7, 1967; Serial Number 663,187; 5 Claims. (Cl. 42–75).

3,405,471; **FIREARM HAVING DISCONNECTABLE SECTIONS**; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia; assignors to Zavody Jana Svermy, narodni podnik; Brno, Czechoslovakia; a corporation; Filed May 23, 1967; Serial Number 640,699; Claims priority, application Czechoslovakia; May 24, 1966; 3,436/66; 3 Claims. (Cl. 42–75).

3,405,599; **WEAPON STABILIZATION SYSTEM**, Roland J. Barlow, Fraser, Jack M. Brandstadter, Royal Oak, John E. Taylor, Utica, and Arthur J. Wroble, Grosse Pointe, Michigan, assignors to Cadillac Gage Company, Warren Michigan. Filed December 2, 1964; Serial Number 415,342; 6 Claims. (Cl. 89–41).

October 29, 1968

3,407,526; **REVOLVER-TYPE PISTOL FOR FIRING SHOTGUN CARTRIDGES**; George H. Freed, Pine Brook, N.J.; assignor of fifty percent to Frank C. Scerbo, Morristown, N.J.; continuation in part of application Serial Number 534,844; March 16, 1966; This application December 1, 1966; Serial Number 607,341; 13 Claims. (Cl. 42--59).

3,407,701; **GAS DRIVE FOR A ROTATING BARREL GUN**; Robert Ernest Chiabrandy, Burlington, Vt.; assignor to General Electric Company, a corporation of New York; Filed July 17, 1967; Serial Number 653,917; 8 Claims (Cl. 89–126).

3,407,702; **AUTOMATIC FIREARM WITH RETARDED BLOWBACK BREECH MECHANISM**; Jiri Cermak and Bohuslav Novotny, Brno, Czechoslovakia; assignors to Vyzkumny a vyvojovy ustav Zavod vseobecneho strojirenstvi, Brno, Czechoslovakia; Filed June 8, 1967; Serial Number 644,617, 6 Claims. (Cl. 89–194).

November 5, 1968

3,408,761; **AMMUNITION LAUNCHER FIRING MECHANISM WITH BREECH CLOSURE MEANS**; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 13, 1961; Serial Number 116,886; 7 Claims. (Cl. 42–1).

3,408,762; **CHOKE FOR SHOTGUNS**; America Durao, 52, Caminjo de Santo Antonio, Funchal, Ilha da Madeira, Portugal; Filed November 2, 1966; Serial Number 591,635; Claims priority; application Portugal, January 29, 1966; 45,320; 4 Claims. (Cl. 42–79).

3,408,895; **FIREARM WITH ADJUSTABLE LOCK-UP TIME DEVICE**; Gilbert A. Lopez, Fort McKavett, Texas, 76841; Filed January 3, 1967; Serial Number 606,685; 6 Claims. (Cl. 89--145).

November 12, 1968

3,410,171; **COCKING DEVICE FOR AUTOMATIC FIREARMS**; Clemens Breiner, Dusseldorf, Germany; assignor to Firma Rheinmetall G.m.b.H.; Dusseldorf, Germany; Filed June 23, 1967; Serial Number 649,474; Claims priority; application Germany; June 28, 1966; R 42,561; 7 Claims. (Cl. 89–1).

3,410,173; ROUND CONTROL DEVICE; Bengt I. Piskafor, Chicopee Falls, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed November 13, 1967; Serial Number 682,685; 5 Claims. (Cl. 89—33).

3,410,174; HYDRAULIC BRAKE WITH COMPENSATION CHAMBER FOR GUN RECOIL; Wilhelm Hahn, Dusseldorf, Germany; assignor to Rheinmetall G.m.b.H.; Dusseldorf, Germany; a company of Germany; Filed December 27, 1966; Serial Number 604,698; Claims priority, application Germany; December 30, 1965; R 42,244; 7 Claims. (Cl. 89—43).

3,410,175; RECOIL ASSEMBLY FOR FIREARM; James H. Johnson, New Haven and Julius E. Brooks, Branford, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed October 23, 1965; Serial Number 505,313; 7 Claims. (Cl. 89—159).

November 19, 1968

3,411,229; BARREL FOR FIRING PRACTICE AMMUNITION FROM AUTOMATIC FIREARMS; Richard Gronemann, Furth, Germany; assignor to Dynamit Nobel A.G.; Troisdorf, Germany; Filed November 28, 1966; Serial Number 597,271; Claims priority, application Germany, November 26, 1965; D 48,760; 4 Claims. (Cl. 42—77).

3,411,403; PROPELLANT LINED HIGH VELOCITY ACCELERATOR; Charles A. Rodenberger, College Station, Texas, (508 Crescent Drive, Bryan, Texas, 77801); Filed April 14, 1967; Serial Number 631,045; 2 Claims (Cl. 89—8).

3,411,404; GUN BARREL LOCATING STRUCTURE; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed December 29, 1966; Serial Number 605,825; 9 Claims. (Cl. 89—163).

3,411,405; GUN HEAD SPACE TAKEUP ELEMENTS; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed December 29, 1966; Serial Number 605,826; 10 Claims. (Cl. 89—196).

3,411,406; GUN BARREL BUSHING STRUCTURES; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assigners to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed December 29, 1966; Serial Number 605,827; 16 Claims. (Cl. 89—196).

3,411,407; GUN SLIDE GUIDING DEVICES; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed December 29, 1966; Serial Number 605,828; 23 Claims. (Cl. 89—196).

3,411,408; MOUNTING STRUCTURE FOR PISTOL BARRELS; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; a corporation of California; Filed December 29, 1966; Serial Number 605,829; 14 Claims. (Cl. 89—196).

November 26, 1968

3,412,642; AUTOMATIC FIREARM HAVING A BREECH BLOCK WITH FRONT AND REAR CARTRIDGE DRIVING MEANS; Hartmut Menneking, Dusseldorf, Germany; assignor to Rheinmetall G.m.b.H.; Dusseldorf, Germany; a company of Germany; Filed January 24, 1967; Serial Number 611,393; Claims priority, application Germany; January 29, 1966; R 42,517; 3 Claims. (Cl. 89—33).

December 3, 1968

3,413,888; ELECTRICALLY ACTUATED CARTRIDGE; Victor B. Kelley, 2023 Oliver Street, West Hyattsville, Md., 20782; Filed September 14, 1966; Serial Number 579,431; 9 Claims. (Cl. 89—28).

December 10, 1968

3,415,000; MAGAZINE CATCH MEANS INCLUDING A TRIGGER SAFETY; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia; assignors to Zavodny Jana Svermy, narodni podnik, Brno, Czechoslovakia; a corporation; Filed May 23, 1967; Serial Number 640,607; Claims priority, application Czechoslovakia; May 25, 1966; 3,351/66. 5 Claims. (Cl. 42—70).

3,415,157; ALIGNMENT CONTROL APPARATUS; Robert G. Marchisio, North Andover, and Robert Hennessey, Concord, Mass.; assignors to Itek Corporation, Lexington, Mass.; a corporation of Delaware; Filed May 11, 1967; Serial Number 637,727; 14 Claims. (Cl. 89—41).

December 17, 1968

3,416,252; COMBINATION FIRING AND EJECTING MECHANISM FOR A GRENADE LAUNCHER; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed Apri. 2, 1963; Serial Number 270,117; 6 Claims. (Cl. 42—1).

3,416,253; GUIDE MEANS FOR BOLT-ACTION FIREARMS; Sven Gunnar Olof Larsson, Huskvarna, Sweden; assignor to Husqvarna Vapenfabriks Aktiebolag, Huskvarna, Sweden; Filed November 14, 1966; Serial Number 594,209; Claims priority application Sweden November 15, 1965; 14,693/65; 4 Claims. (Cl. 42—16).

3,416,401; MORTAR AND AMMUNITION; Bernard J. Golbeck, Crystal Lake, and Joseph W. Hunter, Chicago, Ill.; assignors to the United States of America as represented by the Secretary of the Army; Filed May 9, 1956; Serial Number 583,891; 6 Claims. (Cl. 89—1).

3,416,402; ENGINE LAUNCHING DEVICE; Jean-Jacques Griessen, Geneva, Switzerland; assignor to Transurvey Holding Company, Inc., S.A.; Filed October 14, 1966; Serial Number 586,721; Claims priority, application Switzerland; October 22, 2965, 14,628/65; 6 Claims. (Cl. 89—1).

3,416,404; **FIREARMS LOCKING SYSTEM**; Walter E. Fowler, 8560 Culfor Crescent, Norfold, Va., 23503; Filed April 18, 1967; Serial Number 631,688; 1 Claim. (Cl. 89–190).

December 24, 1968

3,417,499; **RECEIVER AND HOUSING ASSEMBLY FOR A FIREARM**; Harold D. Ally,, 10 Sumner Ave., Springfield, Mass., 01108; Original application September 9, 1965; Serial Number 485,850; now Patent Number 3,366,691; dated August 22, 1967; Divided and this application August 14, 1967; Serial Number 660,522; 7 Claims. (Cl. 42–75).

3,417,656; **POWER CONTROLLER AND AUGMENTOR FOR CARTRIDGE AND PYROTECHNICALLY POWERED DEVICES**; John A. Wells, Northridge, Calif.; assignor to Irving Air Chute Company, Inc.; Lexington, Kentucky; a corporation of New York; Filed September 20, 1965; Serial Number 488,482; 2 Claims. (Cl. 89–1).

3,417,657; **TOOTHED ROTOR MECHANISMS FOR AUTOMATIC GUNS FED FROM TWO CARTRIDGE BELTS**; Bernard Maillard, Geneva, and Paul Hug, Aire-Geneva, Switzerland; assignors to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed June 26, 1967; Serial Number 648,930; Claims priority, application Luxembourg, July 1, 1966: 51,456/66; February 23, 1967, 53,661/67; 16 Claims. (Cl. 89–33).

3,417,658; **EMPTY CASE EJECTOR MECHANISM**; Edward R. Betzold and Carl T. Johnson, Minneapolis, Minn.; assignors by mesne assignments to the United States of America as represented by the Secretary of the Navy; Filed July 31, 1967; Serial Number 658,310; 8 Claims. (Cl. 89–33).

3,417,659; **VEHICULAR SUPPORT FOR A MORTAR**; Ewald Peppe, Overvellmar, Germany; assignor to Rheinstahl Henschel A.G., Kassel, Germany; a corporation of Germany; Filed February 16, 1967; Serial Number 616,718; Claims priority, application Germany, November 11, 1966; R 44,550; 5 Claims. (Cl. 89–40).

3,417,660; **SHOCK ABSORBER FOR AN AUTOMATIC FIREARM**; Karl Heibrecht, Eisental, near Buhl, Germany; assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed October 5, 1966; Serial Number 584,413; Claims priority, application Germany, October 8, 1965; R 41,719; 1 Claim. (Cl. 89–198).

December 31, 1968

3,418,741; **FIREARM**; Bruno Tschaepe, Karlsruhe-Durlach, Germany; assignor to Dynamit Nobel Aktiengesellschaft, Troisdorf, Germany; Filed August 6, 1966; Serial Number 575,325; Claims priority, application Germany, September 8, 1965; D 48,145; 3 Claims. (Cl. 42–77).

3,418,878; **METHOD AND MEANS FOR AUGMENTING HYPERVELOCITY FLIGHT**; James A. Stricklin, Texas A&M University, College Station, Texas, 77840; Filed June 2, 1967; Serial Number 643,201; 8 Claims. (Cl. 89–8).

3,418,879; **ROUND CONTROL DEVICE**; Frederick R. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 27, 1967; Serial Number 649,353; 4 Claims. (Cl. 89–33).

3,418,880; **AUTOMATIC FIREARM WITH BREECH CASING FREE TO RECOIL ON A SUPPORT**; Heinrich Herlach, Zurich, Switzerland, Filed July 28, 1966; Serial Number 565,430; Claims priority; application Switzerland, July 29, 1965; 10,699/65; 4 Claims. (Cl. 89–42).

January 7, 1969

3,420,139; WEDGE BREECH BLOCK FOR GUNS WITH EXCHANGEABLE RING PACKINGS; Erich Bartels, Ratingen, near Dusseldorf, Germany; assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; a corporation of Germany; Filed December 6, 1967; Serial Number 688,487; Claims priority, application Germany, December 14, 1966; R 44,800; 10 Claims. (Cl. 89–17).

3,420,140; MECHANISM FOR DELAYING RELEASE OF BOLT AFTER FIRING A FIREARM; Carlo Pietro Beretta, Gardone Val Trompia, Italy; assignor to Fabbrica d'Armi Pietro Beretta S.p.A., Gardone Val Trompia, Brescia, Italy; Filed March 17, 1967; Serial Number 624,041; Claims priority, application Italy, March 25, 1966, 16,018/66 4 Claims. (Cl. 89–193).

January 14, 1969

3,421,242; FIREARM EJECTOR; Albert J. Lizza, Wilbraham, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 23, 1961; Serial Number 112,124; 3 Claims. (Cl. 42–25).

3,421,243; FIRING MECHANISMS FOR DOUBLE BARREL, SINGLE TRIGGER FIREARMS; Val A. Browning, Ogden, Utah; assignor to Browning Industries, Incorporated, Ogden, Utah; a corporation of Utah; Filed September 18, 1967; Serial Number 668,610; 9 Claims. (Cl. 42–42).

3,421,244; FIRING MECHANISM FOR A RIFLE MOUNTED AUXILIARY FIREARM; Frederick P. Reed, Ludlow, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 2, 1962; Serial Number 177,706; 6 Claims. (Cl. 42–69).

3,421,408; FEED SYSTEM FOR CARTRIDGES; Joseph A. Badali, 492 Shore Drive, Branford, Conn., 06405, and Arnold L. Fowler, 2569 Long Hill Road, Guilford, Conn., 06437; Filed January 31, 1967; Serial Number 612,926; 3 Claims. (Cl. 89–33).

3,421,409; CARTRIDGE FEED SYSTEM; David Findlay, Guilford, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed May 9, 1967; Serial Number 637,237; 8 Claims. (Cl. 89–33).

January 21, 1969

3,422,559; HANDGRIP OPERATED SAFETY MECHANISM FOR HANDGUNS; David S. Woloch, 522 Overwood Road, Akron, Ohio, 44313; Filed June 13, 1967; Serial Number 645,656; 5 Claims. (Cl. 42–66).

3,422,560; ADJUSTABLE GUN TRIGGER LOCKS; Timothy C. Foote, Brookfield, and Kenneth H. Buchamann, Menomonee Falls, Wis.; assignors to Master Lock Company, Milwaukee, Wisconsin; a corporation of Wisconsin; Filed May 25, 1966; Serial Number 552,759; 3 Claims. (Cl. 42–70).

3,422,723; LIQUID-PROPELLANT GUNS AND RELATED DEVICES; Rodney W. Gordon, 28 Keyport Road, New Monmouth, N.J., 07748; Filed November 29, 1966; Serial Number 597,643; 4 Claims. (Cl. 89–8).

January 28, 1969

3,424,052; MOUNT FOR LIGHT GUNS; Walter Ruf, Landhaus am See, Thurgau, Switzerland; Filed April 7, 1967; Serial Number 629,223; Claims priority, application Germany, July 21, 1966; R 43,744; 9 Claims. (Cl. 89–37).

3,424,053; AUTOMATIC FIREARM; Ross A. Close, 3931 Glenbrook Road, Fairfax, Va., 22030; Filed August 18, 1967; Serial Number 661,692; 1 Claim. (Cl. 89–185).

February 4, 1969

3,425,317; MACHINE GUN WITH RAISABLE CARTRIDGE FEEDER COVER; Hartmut Menneking, Dusseldorf, Germany; assignor to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed September 25, 1967; Serial Number 670,266; Claims priority, application Germany, September 27, 1966; R 44,209; 8 Claims. (Cl. 89–33).

3,425,318; RECOIL ISOLATOR FOR MACHINE GUNS AND THE LIKE; Albert Simeon Whitehill, Erie, Pa.; assignor to Lord Corporation, Erie, Pa.; a corporation of Pennsylvania; Filed December 14, 1966; Serial Number 601,588; 10 Claims. (Cl. 89–42).

February 11, 1969

3,426,465; FIREARM WITH NON-BINDING MANUAL BOLT ACTION; Thomas R. Robinson, Jr., New Haven, Conn.; assignor to The Marlin Firearms Company, New Haven, Conn.; a corporation of Connecticut; Filed July 3, 1967; Serial Number 650,816; 12 Claims. (Cl. 42–16).

February 18, 1969

3,427,741; SELF-ARMING GRENADE LAUNCHER; Harold H. Wiese, Davenport, Iowa; assignor to the United States of America as represented by the Secretary of the Army; Filed October 10, 1967; Serial Number 674,353; 7 Claims. (Cl. 42–1).

3,427,922; LOADER'S SAFETY SWITCH; Donald L. Wagner, Detroit, Michigan; assignor by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed November 13, 1967; Serial Number 682,686; 4 Claims. (Cl. 89–28).

3,427,923; STORAGE OF LINKED AMMUNITION FOR CARTRIDGE FEED SYSTEMS; Elwyn A. Meyer, Granite City, Ill., and Charles L. Brownfield, St. Louis, Mo.; assignors to Emerson Electric Company, St. Louis, Mo.; a corporation of Missouri; Filed February 8, 1967; Serial Number 614,703; 13 Claims. (Cl. 89–33).

3,427,924; ELECTRICALLY FIRED GUN AND CARTRIDGE THEREFOR; Erich Cornelius Johnson, 1205 Broad Street, Victoria, British Columbia, Canada; Filed October 20, 1966; Serial Number 588,094; 8 Claims. (Cl. 89–135).

3,427,925; ACTUATING DEVICE FOR AUTOMATIC FIREARMS; Kurt Horn, Oberndorf (Neckar), Germany; assignor to Heckler and Kock (G.m.b.H., Oberndorf (Neckar), Germany; Filed July 7, 1966; Serial Number 563,490; Claims priority application Germany, July 15, 1965; H 56,596; 23 Claims. (Cl. 89–136).

February 25, 1969

3,429,220; SMALL ARMS AMMUNITION BELT; Basil Wanless Kelley Goode, Masons Vernham Dean, Andover, Hampshire, England; Filed October 6, 1966; Serial Number 584,823; Claims priority, application Great Britain, October 11, 1965; 43,119/65; 10 Claims. (Cl. 89–33).

3,429,221; CONSTANT VELOCITY CONVEYOR MECHANISM; Robert G. Kirkpatrick, Shelburne, Vt.; assignor to General Electric Company; a corporation of New York; Filed December 18, 1967; Serial Number 691,478; 4 Claims. (Cl. 89–33).

3,429,222; DRIVE MEANS FOR CUPOLA OF TANK VEHICLE; Donald H. Whiston, Arlington Heights, and Edward J. Flannery, Park Ridge, Ill.; assignors to Vapor Corporation, Chicago, Ill.; a corporation of Delaware; Filed April 8, 1968; Serial Number 719,405; 10 Claims. (Cl. 89–41).

3,429,223; ROTATING LOCK FOR AUTOMATIC FIREARM; Robert Charles Seccombe, 946 Glencoe Road, Glencor, Ill., 60022; Continuation in part of application Serial Number 576,349; August 31, 1967. This application February 28, 1968, Serial Number 708,939; 7 Claims. (Cl. 89–172).

March 4, 1969

3,430,534; DEVICE FOR COMPENSATING RECOIL TORQUES IN TANK TURRETS; Sven Birger Agren, Ornskoldsvik, Sweden; assignor to Aktiebolaget Hagglund & Soner, Ornskoldsvik, Sweden; a corporation of Sweden; Filed October 24, 1967; Serial Number 677,693; Claims priority; application Sweden, October 27, 1966; 14,743/66; 4 Claims; (Cl. 89–42).

March 11, 1969

3,431,668; FIREARM RECEIVER AND BOLT WITH COOPERATING GUIDE MEANS; Robert J. Creamer, East Haven, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed June 22, 1967; Serial Number 648,004; 2 Claims. (Cl. 42–16).

3,431,669; FIREARM EJECTOR; Edward L. Morrow, Fairfield, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed February 25, 1966; Serial Number 530,145; 10 Claims. (Cl. 42–25).

3,431,815; DISCARDABLE ROTATING BAND; William F. Kaufmann, Jr., Philadelphia, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed January 24, 1968; Serial Number 700,213; 1 Claim. (Cl. 89–1).

3,431,816; MOBILE GAS-OPERATED ELECTRICALLY-ACTUATED PROJECTILE FIRING SYSTEM; John R. Dale, 2435 Ball Road, Willow Grove, Pa., 19090; Filed July 21, 1967; Serial Number 655,242; 3 Claims. (Cl. 89–8).

3,431,817; ANTI-DOUBLE FEED DEVICE; William B. Walkup, Mattapoisett, Mass.; assignor to General Electric Company, a corporation of New York; Filed January 2, 1968; Serial Number 695,099; 4 Claims. (Cl. 39–12).

3,431,818; LIGHTWEIGHT PROTECTIVE ARMOR PLATE; Harry A. King, Covina, Calif.; assignor to Aerojet-General Corporation, El Monte, Calif.; a corporation of Ohio; Continuation in part of application Serial Number 246,490; December 21, 1962; This application April 26, 1965; Serial Number 450,657; 11 Claims. (Cl. 89–36).

3,431,819; FIRING MECHANISM FOR FIREARMS; Josef Koucky and Frantisek Koucky, Prague, Czechoslovakia; assignors to Zavody Kana Scermy, narodni podnik; Prague, Czechoslovakia; a corporation; Filed May 23, 1967; Serial Number 640,711; Claims priority; application Czechslovakia, May 24, 1966, PV 3,484/66; 5 Claims. (Cl. 89–145).

3,431,820; GRENADE LAUNCHER; George M. Chinn, Harrodsburg, Ky.; William P. Schnatter, Jeffersonville, Inc., and Henry F. Watson, Louisville, Kentucky; assignors by direct and mesne assignments to the United States of America as represented by the Secretary of the Navy; Filed March 13, 1968; Serial Number 712,637; 6 Claims. (Cl. 89–161).

March 18, 1969

3,432,955; **REMOVABLE COCKING HANDLE FOR A FIREARM BREECH BOLT AND MOUNTING MEANS THEREFOR**; Edwin S. Vartanian, North Haven, and Jay P. Jarvis, North Branford, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed October 25, 1967; Serial Number 677,936; 4 Claims. (Cl. 42–16).

3,432,956; **TUBULAR MAGAZINE FIREARM WITH CARRIER RELEASE AND LATCH**; Edward L. Morrow, Fairfield, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed December 14, 1967; Serial Number 690,562; 5 Claims. (Cl. 42–17).

March 25, 1969

3,434,380; **SALVO-FIRING OPEN CHAMBER GUN**; David Dardick, Palos Verdes Peninsula, Calif.; assignor to TRW Inc., Redondo Beach, Calif.; a corporation of Ohio; Filed September 1, 1967; Serial Number 665,139; 8 Claims. (Cl. 89–13).

3,434,381; **MULTIRING SEAL FOR OBTURATING THE BREECH OF LARGE CALIBER GUNS**; Robert J. Thierry, Averill Park, N.Y.; assignor to the United States of America as represented by the Secretary of the Army; Filed April 23, 1968; Serial Number 723,468; 16 Claims. (Cl. 89–26).

3,434,382; **SECURING A GUN TURRET ON AN ARMORED VEHICLE**; Karl Kirsch Haunstetten, and Siegfried Uhl and August Schiele, Augsburg, Germany; assignors to Keller & Knappich G.m.b.H., Augsburg, Germany; a corporation of Germany; Filed February 20, 1967; Serial Number 617,217; Claims priority application Germany; March 3, 1966; K 58,620; 5 Claims. (Cl. 89–36).

3,434,383; **ENERGY DISCHARGE DEVICE**; John G. Rocha, Westfield, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed April 17, 1968; Serial Number 722,045; 9 Claims. (Cl. 89–42).

April 1, 1969

3,435,549; **PUMP TYPE TUBULAR MAGAZINE REPEATING FIREARM**; Alfred F. Kermode, 201 Cisco, Ridgecrest, Calif., 93555; Filed September 1, 1967; Serial Number 665,687; Int. Cl. F41c 11/00; F41d 9/00; F41 1/00; 15 Claims. (Cl. 42–17).

3,435,727; **GUN HAVING MOVABLY MOUNTED BARREL**; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assignors to Pachmayr Gun Works, Inc., Los Angeles, Calif.; a corporation of California; Orignial application December 29, 1966; Serial Number 605,825; Divided and this application May 29, 1968; Serial Number 733,142; 10 Claims. (Cl. 89–163).

3,435,728; **GUN RECOIL SPRING ASSEMBLY**; Frank A. Pachmayr and Edward B. Miller, Los Angeles, Calif.; assignors to Pachmayr Gun Works, Inc., Los Angeles, Calif.; a corporation of California; Original application December 29, 1966; Serial Number 605,825; Divided and this application May 31, 1968; Serial Number 733,367; 11 Claims. (Cl. 89–199).

April 8, 1969

3,437,005; **FLEXIBLE ARTICLE CONVEYOR FOR HIGH SPEED APPLICATIONS**; Jay M. Trumper, Burlington, Vt.; assignor to General Electric Company; a corporation of New York; Filed May 25, 1967; Serial Number 641,252; 6 Claims. (Cl. 89–33).

3,437,006; **AUTOMATIC FIREARM WITH BREECH MECHANISM UNLOCKED BY THE RECOILING BARREL**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed April 1, 1968; Serial Number 717,841; Claims priority, application Luxembourg, October 6, 1967, 54,608; 9 Claims. (Cl. 89–169).

April 15, 1969

3,438,304; **DEVICE FOR MOUNTING A GUN BENEATH THE WING OF AN AIRPLANE**; Pierre Sautier, Paris, and Paul Bouillard, Clamart, France; assignors to Engins Matra, Paris, France; a French company; Filed May 16, 1967; Serial Number 638,972; Claims priority, application France; May 18, 1966; 62,096; 2 Claims. (Cl. 89–37.5).

3,438,305; **GUN SIGHTING SYSTEM**; Anthony R. Nollett, South Acton, Mass.; assignor to GCA Corporation, Bedford, Mass.; a corporation of Delaware; Continuation in part of application Serial Number 593,875; November 14, 1966; This application June 29, 1967; Serial Number 661,740; 14 Claims. (Cl. 89–41).

April 22, 1969

3,439,441; **MOUNTING OF GUN BARREL AND ACTION ASSEMBLY IN GUN STOCK**; Charles F. Lawley, R.D. 5, Shavertown, Pa., 18708; Filed July 13, 1967; Serial Number 650,710; 6 Claims. (Cl. 42–75).

3,439,577; **DEVICE FOR FEEDING AND LOADING AN EXPLOSION GENERATOR WITH EXPLOSIVE CHARGES**; Claude Duconge, Le Vesinet, and Pierre Magneville, Vernouillet, France; assignors to Institut Francais du Petrole, des Carburants et Lubrifiants, Ruell-Maimaison, Hauts-de-Seine, France; Filed October 13, 1967; Serial Number 675,208; Claims priority application France, October 18, 1966; 80,485; 8 Claims. (Cl. 89–1).

April 29, 1969

3,440,751; **FIREARM BOX MAGAZINE WITH STRAIGHT END AND INTERMEDIATE ARCUATE PORTIONS**; Robert D. Fremont, Farmington, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed June 30, 1967; Serial Number 650,275; 3 Claims; (Cl. 42–50).

3,440,924; **BLANK FIRING ATTACHMENT FOR FIREARMS**; Benjamin Robinson Sawyer, Waltham Cross, England; assignor to The Secretary of State for Defence in Her Britannic Majesty's Government of the United Kingdom of Great Britain and Northern Ireland, London, England; Filed March 17, 1967; Serial Number 624,069; Claims priority, application Great Britain, March 17, 1966, 11,684/66; January 27, 1967, 4,159/67; 18 Claims. (Cl. 89–14).

3,440,925; **AUTOMATIC FIREARM WITH BURST CONTROL MEANS**; Ernest Henri Verview, Oupeye, Belgium; assignor to Fabrique Nationale d'Armes de Guerre, Societe Anonyme, Herstal-lez-Liege, Belgium; Filed May 23, 1968; Serial Number 731,491; Claims priority, application Belgium, July 7, 1967, 41,418; 11 Claims. (Cl. 89–129).

3,440,926; **CONTROL CIRCUITRY FOR AUTOMATICALLY OPERATED GUNS**; Robert J. Gura, Lyndhurst, and Edward G. Hodina, Willoughby, Ohio; assignors to TRW Inc., Cleveland, Ohio, a corporation of Ohio; Filed December 4, 1967; Serial Number 687,708; 10 Claims. (Cl. 89–135).

May 6, 1969

3,442,042; **ROTATABLE AND SLIDABLE GUNSTOCK**; William Van Tyle Gilbert, 3165 Ferndale St., Las Vegas, Nev., 89109; Continuation-in-part of application Serial Number 490,180; September 27, 1965; This application June 12, 1967; Serial Number 645,208; 5 Claims; C.L. 42–73).

3,442,172; **GUN BARREL LINER**; Ralph F. Wehrmann, North Chicago, and Roy H. Lorenz, Arlington Heights, Ill.; assignors to Fansteel Inc., a corporation of New York; Filed March 13, 1959; Serial Number 799,386; 6 Claims. (Cl. 89–16).

3,442,173; **COMBINED RIFLE AND GRENADE LAUNCHER WEAPON SELECTIVELY FIRED BY A SINGLE TRIGGER**; James H. Muller, Jefferson, Ke.; assignor to the United States of America as represented by the Secretary of the Army; Filed May 28, 1968; Serial Number 732,586; 9 Claims. (Cl. 89–127).

May 13, 1969

3,443,334; **CARTRIDGE MAGAZINE WITH A SPRING WHOSE FORCE AGAINST THE CARTRIDGE MAY BE SELECTIVELY INCREASED**; Edward J. Ardolino, 6 Whiting Farms Road, Branford, Conn., 06405; Filed August 28, 1967; Serial Number 663,868; 3 Claims, (Cl. 42–50).

3,443,476; **CONTROL SYSTEM FOR ROTATABLE GUN PLATFORM AND OPTICAL SIGHT**; Helmut Helder and Helmut Looss, Hamburg, Germany; assignors to Licentia Patent-Verwaltungs-G.m.b.H.; Frankfurt am Main, Germany; Filed September 1, 1966; Serial Number 577,122; Claims priority, application Germany, September 1, 1965; 6 Claims. (Cl. 89–41).

3,443,477; **GAS OPERATED FIREARM**; Arthur J. Kaempf, 311 Loon Lake Road, Shawano, Wis., 54166; Filed October 26, 1967; Serial Number 678,364; 10 Claims. (Cl. 89–128).i,

May 20, 1969

3,444,639; **SAFETY PLUGFOR FIREARM CHAMBER**; Clyde R. Rockwood, 4361 Woodhall Road, Columbus, Ohio, 43221; Continuation of application Serial Number 589,940; October 27, 1966. This application April 19, 1968; Serial Number 722,718; 4 Claims. (Cl. 42–1).

3,444,640; **FIRING MECHANISM FOR DOUBLE-BARRELLED SHOTGUNS**; Ernest P. Simmons, 1000 Sheridan Place, Olathe, Kansas, 66061; Filed July 19, 1967; Serial Number 654,431; 2 Claims. (Cl. 42–42).

3,444,641; **GUN RECEIVER-BARREL-STOCK COMBINATION**; William B. Ruger, Southport, Conn.; assignor to Sturm, Ruger & Co., Inc.; Southport, Conn.; a corporation of Connecticut; Filed August 2, 1967; Serial Number 657,805; 5 Claims. (Cl. 42–75).

3,444,780; **TUBULAR AMMUNITION RACK AND HOUSING**; Rex A. Fusee, Madison Heights, Mich.; assignor to the United States of America as represented by the Secretary of the Army; Filed March 5, 1968; Serial Number 710,610; 7 Claims. (Cl. 89–34).

May 27, 1969

3,445,951; **BAYONET ADAPTER AND MAGAZINE EXTENSION TUBE**; John J. Bechard, Ilion, Walter L. Dahl, Herkimer, James S. Martin and Clark S. Workman, Mohawk, N.Y.; and David J. Sankey, Wilmington, Del., assignors to Remington Arms Company, Inc., Bridgeport, Conn., a corporation of Delaware; Filed July 27, 1967; Serial Number 656,418; 6 Claims. (Cl. 42–86).

3,446,111; **RECOILLESS OPEN CHAMBER GUN**; David Dardick, Palos Verdes Peninsula, Calif.; assignor to TRW Inc., Redondo Beach, Calif.; a corporation of Ohio; Filed September 1, 1967; Serial Number 664,979; 7 Claims. (Cl. 89–1.7).

3,446,113; **SEALED OPEN CHAMBER BREECH MECHANISM**; David Dardick, Palos Verdes Peninsula, Calif.; assignor to TRW Inc., Redondo Beach, Calif.; a corporation of Ohio; Filed September 1, 1967; Serial Number 671,910; 25 Claims. (Cl. 89–26).

3,446,114; **TRIGGER MECHANISM FOR AUTOMATIC FIREARMS**; Wilhelm Ketterer, Oberndorf-Lindenhof, Germany; assignor to Heckler & Kich G.m.b.H.; Filed December 18, 1967; Serial Number 691,288; Claims priority; application Germany, December 20, 1966; H 61,342; 8 Claims. (Cl. 89–140).

3,446,115; **OPEN CHAMBER BREECH MECHANISM WITH SCARFED FIRING STRAP**; Frank Fedowitz, Jr.; Cypress, Calif.; assignor to TRW Inc., Redondo Beach, Calif.; a corporation of Ohio; Filed October 6, 1967; Serial Number 673,456; 4 Claims. (Cl. 89–155).

June 3, 1969

3,447,417; **GUN WITH A FLOATING BREECH BOLT**; Bruno Civolani, Bologna, Italy; assignor to Benelli S.p.A.; Divisione Armi, Viale Mameli, Italy; a corporation of Italy; Field February 27, 1967; Serial Number 618,595; Claims priority; application Italy, March 9, 1966; 1 Claim. (Cl. 89–182).

3,447,418; **BREECHCASE FOR FIREARM**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; a society of Switzerland; Filed April 1, 1968; Serial Number 717,524; Claims priority; application Luxembourg, July 31, 1967; 9 Claims; (Cl. 89–199).

June 10, 1969

3,448,654; **GRENADE EJECTOR**; Royale R. Crabtree, Towson, and Charles W. Beeker, Parkville, Md.; and Dennis E. Mead, Los Angeles, Calif.; assignors to the United States of America as represented by the Secretary of the Army; Filed March 5, 1968; Serial Number 710,455; 12 Claims. (Cl. 89–1.5).

June 24, 1969

3,451,154; **SAFETY FOR FIREARMS**; Ralph O. Goble, Morristown, Ind., 46161; Filed August 21, 1967; Serial Number 662,010; 4 Claims. (Cl. 42–70).

3,451,307; **ELECTRONIC CONTROL CIRCUIT FOR CONTROLLING THE RATE OF FIRE OF A MACHINE GUN**; Kenneth Grundberg, 3012 Maplewood, Royal Oak, Mich., 48073; Filed December 6, 1967; Serial Number 688,483; 10 Claims; (Cl. 89–135).

July 1, 1969

3,452,640; **AUTOMATIC AND SEMI-AUTOMATIC GUNS HAVING A DOUBLE FEED MECHANISM**; Bernard Maillard, Geneva, Switzerland; assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Filed March 13, 1967; Serial Number 622,643; Claims priority, application Luxembourg, September 29, 1966; 10 Claims. (Cl. 89–33).

July 8, 1969

3,453,762; **DISPOSABLE MAGAZINE HAVING A PROTECTIVE COVER AND FOLLOWER RETAINING MEANS**; Robert D. Fremont, Farmington, Conn.; assignor to Colt's Inc., Hartford, Conn.; a corporation of Arizona; Filed June 19, 1967; Serial Number 646,981; 10 Claims. (Cl. 42–50).

3,453,763; **UNDERWATER PISTOL HAVING A ROTATABLE CYLINDRICAL MAGAZINE**; Irwin R. Barr, Lutherville, and John L. Critcher, Cockeysville, Md.; assignors to AAI Corporation, Cockeysville, Md.; a corporation of Maryland; Filed June 30, 1967; Serial Number 650,573; 20 Claims. (Cl. 42–59).

3,453,764; **ELECTRONIC FIRING MECHANISM**; Gerard Grollwau, Rue Montbelliard F-90, Danjoutin, France; Filed June 23, 1967; Serial Number 648,297; Claims priority, application France, June 28, 1966; 67,265; 3 Claims. (Cl. 42–84).

3,453,929; **GUN PORT SHIELD**; Edward R. Betzold and William M. Magers, Minneapolis, Miss.; assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed August 11, 1966; Serial Number 572,168; 7 Claims. (Cl. 89–36).

July 15, 1969

3,445,047; **MUZZLE PATCH FOR FIREARMS**; Charles Rex Hoad, 260 East 1100 North, North Salt Lake City, Utah, 84054; Filed November 15, 1967; Serial Number 683,244; 4 Claims. (Cl. 42–1).

3,455,202; **LIQUID PROPELLANT-ACTUATED DEVICE**; Glenn R. Dixon, Brecard, N.C., and David Findlay, Guilford, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed January 25, 1968; Serial Number 700,439; 3 Claims. (Cl. 89–7).

3,455,203; **MULTI-LINEAR NOZZLE BALLISTIC ATTENUATOR OF RECOIL, BLAST FLASH**; Arthur Pillersdorf, 626 Burkley Avenye; Aberdeen, Md., 21001; Filed March 22, 1967; Serial Number 625,060; 14 Claims. (Cl. 89–14).

3,455,204; **FEEDING MECHANISM FOR AN AUTOMATIC GUN**; Eugene M. Stoner, Rte 1, Box 70, Port Clinton, Ohio, 43452; Filed September 29, 1965; Serial Number 491,300; 16 Claims. (Cl. 89–33).

July 22, 1969

3,456,375; **FIREARM BOLT-STRIKER ASSEMBLY INCLUDING A BOLT HANDLE AND POWER SPRING**; Joseph A. Badali, Branford, Victor Alexander Kulokowski, Hamden, and Edwin S. Vartanian, North Haven, Conn.; assignors to Olin Mathieson Chemical Corporation; a corporation of Virginia; Original application March 8, 1967; Serial Number 636,787, now Patent Number 3,387,400; dated June 11, 1968. Divided and this application December 4, 1967, Serial Number 712,877; 3 Claims. (Cl. 42–16).

3,456,553; **MAGAZINE FOR FEEDING BELTED AMMUNITION TO AUTOMATIC FIREARMS**; Bohuslav Novotny and Jiri Cermak, Brno, Czechoslovakia; assignors to Vyzkumny a vyvojovy ustav Zavodu Vseobecneho Strojirenstvi; a corporation of Czechoslocakia; Filed January 29, 1968; Serial Number 701,183; Claims priority application Czechoslovakia; February 6, 1967, 5 Claims. (Cl. 89–33).

3,456,554; **PULSE COUNTER AND BURST LIMITER**; Arthur F. Goodwin, Essex Junction, Vt., assignor to General Electric Company; a corporation of New York; Filed Jnauary 2, 1968; Serial Number 695,096; 4 Claims. (Cl. 89–135).

July 29, 1969

3,457,827; **TURRET GUN DIRECTING SYSTEM (AIDEYE)**; Howell M. Sumrall, 420 Lenore, Ridgecrest, Calif., 93555; Filed May 3, 1968; Serial Number 726,616; 2 Claims. (Cl. 89–41).

August 5, 1969

3,459,098; **WEAPON**; Daniel J. Donnelly, Levittown, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 24, 1968; Serial Number 739,471; 4 Claims. (Cl. 89–1).

3,459,101; **HIGH VELOCITY WEAPON**; John J. Scanlon, Jr., Monroe, Conn., and Joseph B. Quinlan, Philadelphia, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed November 9, 1967; Serial Numner 681,691; 4 Claims. (Cl. 89–8).

August 19, 1969

3,461,589; **FIREARM RECOIL REDUCER WITH AN INERTIA MEMBER HAVING VALVE MEANS THEREIN**; Italo D. Vironda, 194 N. Wabash, Battle Creek, Mich., 49017; Continuation in part of application Serial Number 706,021; February 16, 1968. This application September 20, 1968; Serial Number 761,269; 9 Claims. (Cl. 42–74).

3,461,774; **AMMUNITION HOLDER HAVING COMPARTMENTS TO RECIEVE A CARTRIDGE BELT**; Fritz Maurer, Gontenschwil, and Hanspeter Novet, Uster, Switzerland; assignors to Werkzeugmaschinenfabrik Oerlikon Buhrle & Co., Zurich, Switzerland; Filed June 13, 1968; Serial Number 737,788; Claims priority; application Switzerland, June 16, 1967; 8 Claims. (Cl. 89–34).

August 26, 1969

3,462,869; **KEY OPERATED SAFETY LOCK DEVICE FOR FIREARMS**; Charles Coleman Wallace, 2210 E. Arbor Drive, N.E., Huntsville, Ala., 35811; Filed August 14, 1967; Serial Number 660,406; 1 Claim. (Cl. 42–70).

September 2, 1969

3,464,136; **LOCKING PIN AND METHOD FOR LOCKING A GUN BARREL TO A GUN FRAME**; Gary Wilhelm, Hamden, Conn.; assignor to Stoeger Arms Corporation, South Hackensack, N.H.; a corporation of New Jersey; Filed April 1, 1968; Serial Number 717,847; 3 Claims. (Cl. 42–75).

September 9, 1969

3,465,463; **ADAPTER ASSEMBLY FOR MAGAZINE CONTAINING BLANK CARTRIDGES**; Andrew J. Grandy, North Hills, and Angelo S. Spinelli, Philadelphia, Pa., Seymour De Mesquita, Camden, N.J., and Alfred P. Batezell, Montgomery, Pa.; assignors to the United States of America as represented by the Secretary of the Army; Filed March 13, 1968; Serial Number 712,635; 2 Claims. (Cl. 42–50).

3,465,638; **HYPERVELOCITY GUN**; Thomas N. Canning, Sunnyvale, Calif.; assignor to the United States of America as represented by the Administrator of the National Aeronautics and Space Administration; Filed August 23, 1967; Serial Number 662,828; 14 Claims. (Cl. 89–8).

3,465,639; **HYPERVELOCITY JET AND PROJECTILE VELOCITY AUGMENTER**; William C. Cooley, Bethesda, Md.; assignor to Exotech Incorporated, Rockville, Md.; Continuation of application Serial Number 568,368; July 22, 1966. This application December 5, 1967; Serial Number 688,266; 12 Claims. (Cl. 89–8).

3,465,640; **LINK FOR DISINTEGRATING AMMUNITION BELT**; John William Sarvis, P.O. Box 26, Burlington, Vt., 05401; Filed March 7, 1968; Serial Number 711,378; 9 Claims. (Cl. 89–35).

September 23, 1969

3,468,216; **HYPERVELOCITY GUN HAVING A HYDRAULIC STAGE FOR VELOCITY CONVERSION**; Jean F. Charpentier, Akron, Ohio, assignor to Goodyear Aerospace Corporation, Akron, Ohio; a corporation of Delaware; Filed May 13, 1968; Serial Number 728,605; 10 Claims. (Cl. 89–8).

3,468,217; **HYPERVELOCITY JET SYSTEM**; William C. Cooley, Bethesda, Md.; assignor to Exotech Incorporated, Rockville, Md.; Continuation in part of application Serial Number 688,266; Decemver 5, 1967; This application April 24, 1968; Serial Number 723,857; 8 Claims. (Cl. 89–8).

September 30, 1969

3,469,337; **BREECH-LOADING GUN**; Micolaos C. Christakos, 2832 N. Austin Ave., Chicago, Ill., 60634; Filed October 4, 1967; Serial Number 672,850; Claims priority, application Greece, February 28, 1967; 31,748, Patent 8,528; 4 Claims. (Cl. 42–47).

October 7, 1969

3,470,788; **REVOLVER TYPE SEMIAUTOMATIC FIREARM**; Viljo Miilo Virtanen, Sornaisten rantatie 3 A 24, Helsinki 53, Finland; Filed March 28, 1968; Serial Number 716,931; 7 Claims. (Cl. 89–155).

October 14, 1969

3,471,961; **BOLT AND FIRING MECHANISM FOR BOLT ACTION TYPE FIREARM**; Karl R. Lewis, 77 Olney Road, Wethersfield, Conn., 06109; Original application December 6, 1966; Serial Number 609,979, now Patent Number 3,377,730; dated April 16, 1968; Divided and this application April 4, 1968; Serial Number 718,672; 15 Claims. (Cl. 42–20).

October 21, 1969

3,473,434; **AUTOMATIC FIREARM BREECHBLOCK LOCK, THE CONTROL MEMBER OF WHICH IS LATCHED BY A GAS OPERATED SETTING MEMBER**; Hans Brieger, Zurich, Switzerland; assignor to Werkzeugmaschinenfabrik Oerlikon Buhrle & Co., Zurich, Switzerland; Filed May 10, 1968; Serial Number 728,190; Claims priority, application Switzerland, May 12, 1967; 6,780/67; April 19, 1969, 5,846/68; 14 Claims. (Cl. 89–181).

October 28, 1969

3,474,560; **CASELESS CARTRIDGE CHAMBER-SLEEVE EJECTOR AND BINARY FEED SYSTEM**; Marcus Ramsey, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed April 4, 1968; Serial Number 718,799; 6 Claims. (Cl. 42–17).

November 11, 1969

3,477,162; **EXTRACTOR SYSTEM WITH A SINGLE SPRING EXERTING UNEQUAL FORCES UPON TWO FIREARM EXTRACTORS**; Charles H. Morse, Herkimer, N.Y.; assignor to Remington Arms Company, Inc., Bridgeport, Conn.; a corporation of Delaware; Filed December 28, 1967; Serial Number 694,130; 6 Claims. (Cl. 42–25).

November 18, 1969

3,478,643; **BALLISTIC SHIELDING APPARATUS**; Robert W. Forsyth and John P. Forsyth, both of 1517 N. 3rd Ave., Upland, Calif., 91786; Filed April 4, 1968; Serial Number 718,781; 13 Claims. (Cl. 89–36).

3,478,644; TRIGGER MECHANISM FOR AUTOMATIC FIREARMS FOR SELECTIVE FIRING OF A BURST OR A SINGLE SHOT; Jiri Cermak, Brno, and Hindrich Hakubec, Thinov, Czechoslovakia; assignors to Vyzkumny a vyvojovy ustav Zavodu vseobecneho strojirenstvi, Brno, Czechoslovakia; Filed April 9, 1968, Serial Number 719,991; Claims priority, application Czechoslovakia, April 13, 1967; 2,688/67; 7 Claims. (Cl. 89–140).

December 9, 1969

3,482,348; AUTOMATIC HAMMER SAFETY FOR REVOLVERS; Admar Orlando Zanchi, Porto Alegre, Brazil, assignor to Forjas Taurus, S.A. Industria e Comercio, Porto Alegre, Brazil, a corporation of Brazil; Filed February 8, 1968; Serial Number 704,108; Claims priority, application Brazil, August 7, 1967; 191,892; 1 Claim. (Cl. 42–66).

December 16, 1969

3,483,648; ANTI-RECOIL FIREARM; Stephen Speckhart, 78 Lexington Ave., Maplewood, N.J., 07040; Filed March 1, 1968; Serial Number 709,728; 10 Claims. (Cl. 42–10).

3,483,793; PISTON-RAMMER COMPRESSION IGNITION ASSEMBLY; Marcus Ramsay, New Haven, Conn.; assignor to Olin Mathieson Chemical Corporation; a corporation of Virginia; Filed March 4, 1968; Serial Number 710,127; 2 Claims. (Cl. 89–7).

3,483,794; GUN BARREL FOR SILENT LAUNCHING OF A PROJECTILE; Charles F. Packard, Bettendorf, Iowa; assignor to the United States of America as represented by the Secretary of the Army; Filed June 18, 1968; Serial Number 737,905; 3 Claims. (Cl. 89–14).

December 23, 1969

3,484,977; RECOIL ABSORBING ATTACHMENT WITH COMPRESSED AIR RESTORING MEANS THEREIN; Roy L. Younts, 615 N. Mendenhall St., Greensboro, N.C., 27401; Filed May 31, 1968; Serial Number 733,428; 5 Claims. (Cl. 42–74).

3,485,136; AMMUNITION FEED METHOD AND SYSTEM; Ivan N. Vuceta, Los Angeles, Calif.; assignor to TRW Inc., Redondo Beach, Calif.; a corporation of Ohio; Filed April 16, 1968, Serial Number 721,727; 20 Claims. (Cl. 89–34).

December 30, 1969

3,486,411; MULTIPORTION BARREL FOR A LAUNCHER OF FIN-STABILIZED PROJECTILES; Benjamin Lichtenstern, Haifa, Israel; assignor to Etablissement Salgad, Vaduz, Liechtenstein; Filed June 3, 1968; Serial Number 733,970; Claims priority, application Germany, June 5, 1967; 8 Claims. (Cl. 89–16).

January 13, 1970

3,489,058; **BREECH BLOCK FOR USE IN FIRING SUB-CALIBRE TRAINING CARTRIDGES FROM RECOILLESS WEAPONS**; Erik Wilhelm Wallberg, Vallingby, and Karl-Erik Anderson, Eskilstuna, Sweden, assignors to Forsvarets Fabriksverk, Eskilstuna, Sweden, a corporation of Sweden; Filed April 16, 1968, Serial No. 721,654; 6 Claims; (Cl. 89–1.705).

3,489,059; **ROCKET-LAUNCHER MAGAZINE**; Eberhard Berek, Zurich, Switzerland, assignor to Werkzeugmaschinenfabrik Oerlikon Buhrie & Co., Zurich, Switzerland; Filed April 12, 1968, Serial No. 720,809; 2 Claims; (Cl. 89-1.801).

3,489,060; **AUTOMATIC DELAYED BLOWBACK CARBINE**; Michele Pietro Marocchi, Via V. Alfieri 2/A, Gardone Val Trompla, Brescia, Italy; Filed February 26, 1968, Serial No. 708,077; Claims Priority, application Italy, April 22, 1967, 2,748/67; 1 Claim; (Cl. 89–139).

January 20, 1970

3,490,164; **REVOLVER WITH PIVOTABLE CYLINDER**; Gunter Horst Rohm, Sontheim (Brenz), Germany, assignor to Rohm-Gesellschaft G.m.b.H., Werkzeug-und-Machinenfabrik, Sontheim (Brenz), Germany; Filed June 4, 1968, Serial No. 734,296; Claims priority, application Germany, March 9, 1968, R 37,093; 3 Claims; (Cl. 42–62).

3,490,330; **FIREARM, PARTICULARLY LIGHT ANTITANK WEAPON**; Willi Walther, Johlingen, Baden, Germany, assignor to Industrie-Werke Karlsrube Aktiengesellschaft, Karisrube, Germany, a corporation of Germany; Filed March 8, 1968, Serial No. 711,607, Claims priority, application Germany, March 16, 1967, I 33,228; 7 Claims; (Cl. 89–1.7).

January 27, 1970

3,491,473; **CUSHIONED GUN STOCK**; Edward H. Eastin, 254 Rellman Court, Rochester, Michigan 48063, Filed January 8, 1968, Serial No. 697,562; 15 Claims; (Cl. 42–74).

3,491,659; **FIREARM**; Edwin Rahr, Wettingson, Switzerland, assignor to Hammerli A. G., Switzerland, a corporation of Switzerland, Filed August 15, 1967, Serial No. 660,743; Claims priority, application Switzerland, August 18, 1966; 10 Claims. (Cl. 89–194).

February 3, 1970

3,492,748; **PISTOL SAFETY MECHANISM ADAPTED FOR RIGHT OR LEFT HAND OPERATION**; Armad D. Swenson, 3223 W. 145th St., Gardena, California 90249; Filed April 5, 1968, Serial No. 719,100; 7 Claims; (Cl. 42–70).

3,492,749; **FIREARM RECOIL MECHANISM WITH AN INERTIA MEMBER RELEASABLY HELD BY A MAGNET**; Italo D. Vironda, 194 N. Wabash, Battle Creek, Michigan 49017; Filed February 16, 1968, Serial No. 706,021; 12 Claims; (Cl. 42–74).

3,492,750; **MUZZLE CHOKE**; Clifford Logan Ashbrook, 5027 Cheeva 77035 and Wilson Gordon Wing, 33 E. Rivercrest 77042, both of Houston, Texas; Filed November 15, 1967, Serial No. 683,2000; 11 Claims; (Cl. 42–79).

3,492,913; **OPEN CHAMBER GUN AMMUNITION FEED SYSTEM**; Michael J. Barnard, Torrance, California, assignor to TRW Inc., Redondo Beach, California, a corporation of Ohio; Filed March 11, 1968, Serial No. 712,214; 11 Claims; (Cl. 89–33).

3,492,912; **RECOIL CONTROLLING DEVICE**; Clifford Logan Ashbrook, 112 Meyerland Plaza Mall, Houston, Texas 77035, Continuation-in-part of application Serial No. 576,630, September 1, 1966. This application November 7, 1968, Serial No. 774,021; 10 Claims; (Cl. 89–14).

February 10, 1970

3,494,060; **UNDERWATER GUN HAVING A ROTATABLE CYLINDER**; Grover E. Hendricks, 2241 Lake St., Niles, Michigan 49120 Filed March 11, 1968, Serial No. 711,974; 10 Claims; (Cl. 42–65).

3,494,216; **BOLT ACTION FOR REPEATING RIFLE**; Jerry D. Haskins, Enid, Oklahoma, assignor to Champlin-Haskins, Incorporated, Enid, Oklahoma, a corporation of Oklahoma; Filed May 13, 1968, Serial No. 728,715; 12 Claims; (Cl. 42–16).

3,494,251; **FUZE SETTER APPARATUS**; Edwin C. Albrecht, Ludolph M. Larsen, and Milton C. Neuman, Minneapolis, Minnesota and Charles J. Wacker, New Brighton, Massachusetts, assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed October 22, 1968, Serial No. 769,663; 5 Claims; (Cl. 89–6).

February 17, 1970

3,495,349; **ELECTRICALLY-FIRED GUN HAVING A VERTICALLY MOVABLE MISSILE TRANSFERRING AND FIRING CHAMBER MEANS**; William Ansel Thompson, Merryville, La., assignor of fifty percent to Alvin E. Moore, Waveland, Mississippi; Filed December 26, 1967, Serial No. 693,227; 11 Claims; (Cl. 42–84).

February 24, 1970

3,496,667; **CHOKED SHOTGUN WITH RIFLED BARREL**; Edward D. Lowry, New Haven, Connecticut, assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed January 4, 1968, Serial No. 695,696; 5 Claims; (Cl. 42–78).

3,496,827; HIGH FIRING RATE, LIGHT GAS HYPERVELOCITY GUN AND AMMUNITION THEREFOR; David Dardick, Palos Verdes Peninsula, California, assignor to TRW, Inc., Redondo Beach, California, a corporation of Ohio; Filed August 31, 1967, Serial No. 664,882; 18 Claims; (Cl. 89–8).

3,496,828; PERCUSSION DEVICE FOR FIREARMS; Fredric Arno Donner, Rahapakantu 1, Helsinki, Finland; Filed April 11, 1968, Serial No. 720,681; Claims priority, application France, April 10, 1967; 1 Claim. (Cl. 89–26).

3,496,829; ELECTRONIC CADENCE CONTROL FOR AUTOMATIC FIREARMS; Bernd Heuser, Dusseldorf-Eller, and Werner Hilgers, Krefeld, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany, a corporation of Germany; Filed November 13, 1967, Serial No. 682-3,70; Claims priority, application Germany, November 10, 1966; 44,553; 8 Claims; (Cl. 89–135).

3,496,830; ROCKET LAUNCHER WITH A MAGAZINE; Hugo Sigrist, Hinwil, and Armin Roth, Zurich, Switzerland, assignors to Werkzeugmachinenfabrik Oerlikon Buhrie & Co., Zurich, Switzerland; Filed July 24, 1968, Serial No. 747,187; Claims priority application Switzerland, July 26, 1967, 10,626/67; 14 Claims; (Cl. 89–1.801)

March 3, 1970

3,497,983; CARTRIDGE CASE EXTRACTOR FOR AUTOMATIC FIREARMS; Tilo Moller, Brandacker, Germany, assignor to Firma Heckler & Koch G.m.b.H.; Oberndorf, Germany; Filed January 12, 1968, Serial No. 697,337; Claims priority, application Germany, January 12, 1967, H 61,537; 3 Claims; (Cl. 42–25).

3,497,984; AIR OPERATED PROJECTILE FIRING APPARATUS; Ronald W. Joyce, Springdale, Eugene E. Billingslea, Rogers, Leopold C. Sage, Fayetteville, and Robert K. Marshall, Rogers, Arkansas, assignors, by mesne assignments to Victor Comptometer Corporation, Chicago, Illinois, a corporation of Illinois. Original application November 30, 1966, Serial No. 598,087, now Patent No. 3,399,596, dated September 3, 1968. Divided and this application March 29, 1968, Serial No. 739,575; 9 Claims. (Cl. 42–39.5).

3,498,178; CYLINDRICAL AMMUNITION MAGAZINE FOR STORING AND DISCHARGING LINKED AMMUNITION; Elwyn A. Meyer, Granite City, Illinois, and Charles L. Brownfield, St. Louis, Missouri; assignors to Emerson Electric Company; a corporation of Missouri; filed February 23, 1968, Serial No. 707,697; 9 Claims. (Cl. 89–34).

March 17, 1970

3,500,715; FIRING EQUIPMENT; Boris Batou, Geneva, Switzerland, assignor to Mescar S.A., Brussels, Belgium, a firm of Belgium, Filed September 30, 1968, Serial No. 763,838, Claims priority, application Switzerland, October 3, 1967; 2 Claims; (Cl. 89–1).

3,500,718; RECOIL OPERATED AUTOMATIC GUN; Eugene M. Stoner, Rte. 1, Box 70, Port Clinton, Ohio 43452; Filed August 23, 1967, Serial No. 662,614; 41 Claims; (Cl. 89–138).

March 24, 1970

3,501,858; DEVICE AND METHOD FOR CHAMBERING TELESCOPED CASELESS AMMUNITION; Perry J. Hensley, Magna, and James O. Mack, Jr., Salt Lake City, Utah, assignors to Hercules Incorporated, Wilmington, Delaware, a corporation of Delaware; Filed December 28, 1967, Serial No. 694,2111; 10 Claims; (Cl. 42–16).

3,501,996; MAGAZINE FOR GUNS BUILT INTO ARMOURED CUPOLAS; Herbert Lipp and Adolph Nordmann, Dusseldorf, Germany, assignors to Rheinmetall G.m.b.H., Dusseldorf, Germany, a company of Germany, Filed January 19, 1967, Serial No. 610,429; Claims priority, application Germany, January 16, 1966, R 42,487; 4 Claims; (Cl. 89–34).

3,501,997; DYNAMIC FORCE ATTENUATOR FOR A MORTAR; Robert F. Winsen, Oak Park, and Eugene C. Molnar, Warren, Michigan, assignors to the United States of America as represented by the Secretary of the Army; Filed March 21, 1968, Serial No. 714,868; 3 Claims; (Cl. 89–44).

3,501,998; OPEN CHAMBER BREECH MECHANISM WITH EXPLOSION ACTUATED CYLINDER; David Dardick, Palos Verdes Peninsula, California, assignor to TRW, Inc., Redondo Beach, California, a corporation of Ohio; Filed August 31, 1967, Serial No. 664,829; 14 Claims; (Cl. 89–156).

March 31, 1970

3,503,149; REVOLVER FIRING ACTION MECHANISM; Hubert F. Hedges, 85 Richmond Hill, New Canaan, Connecticut 06018, and Richard R. Bergmann, Perry Avenue, Norwalk, Connecticut 06850; Filed January 5, 1968, Serial No. 696,066; 1 Claim; (Cl. 42–65).

3,503,150; CARTRIDGE HOLDER FOR A REVOLVER; Werner O. Brunhuber, Stamford, Connecticut (19 W. 24th St., New York, New York 10010) and William C. Bye, 169 Cypress Ave., Bronx, New York 10454; Filed March 8, 1968, Serial No. 711,701; 6 Claims; (Cl. 42–89).

3,503,299; AIR OPERATED PROJECTILE FIRING APPARATUS; Ronald Wayne Joyce, Springdale, Eugene Elton, Billingslea, Rogers, and Paul Oliver Hurley, Springdale, Arkansas, assignors, by mesne assignments, to Victor Comptometer Corporation, Chicago, Illinois, a corporation of Illinois; filed November 30, 1966, Serial No. 598,086; 12 Claims; (Cl. 89–7).

3,503,300; HIGH FIRING RATE HYPERVELOCITY GUN AND AMMUNITION THEREFOR; David Dardick, Palos Verdes Peninsula, California] assignor to TRW, Inc., Redondo Beach, California, a corporation of Ohio; Filed September 1, 1967, Serial No. 665,155; 20 Claims; (Cl. 89–8).

April 7, 1970

3,504,594; **SUB-CALIBER, SELF-RELOADING FIREARM WITH BARREL POSITION ADJUSTING MEANS** 289 Central Ave., West Caldwell, New Jersey 07006; Filed May 23, 1968, Serial No. 731,465; 7 Claims; (Cl. 89–163).

April 14, 1970

3,505,924; **SILENT MORTAR**; John J. Driscoll, Paris, France, assignor to Allied Research Associated, Inc. Concord, Massachusetts, a corporation of Delaware. Filed April 18, 1967, Serial No. 631,650; 8 Claims; (Cl. 89–1).

3,505,926; **LINE THROWING DEVICE**; Arthur M. Johnson, Silver Spring, Maryland, assignor to Scientific Products Corp. Alexandria, Virginia, a corporation of Virginia; Filed July 9, 1968, Serial No. 743,446; 5 Claims; (Cl. 89–1).

3,505,927; **AUTOMATIC FIREARM HAVING ELECTRICAL IGNITION OF CARTRIDGES IN A ROTATING AND RECIPROCATING CYLINDER**; John H. Driscoll, Paris, France, assignor to Allied Research Associates, Inc., Concord Massachusetts, a corporation of Delaware; Filed November 6, 1967, Serial No. 680,935; 1 Claim; (Cl. 89–135).

April 21, 1970

3,507,067; **GRENADE LAUNCHER HAVING A ROTATABLE FORWARDLY SLIDING BARREL AND REMOVABLE FIRING MECHANISM**; Henry A. Into, Rocky Hill, Connecticut, assignor to Colt's Inc., Hartford, Connecticut, a corporation of Arizona; Filed December 14, 1967, Serial No. 690,672; 23 Claims; (Cl. 42–10).

3,507,185; **CARTRIDGE LINK GUIDE FOR MACHINE GUNS**; Hartmut Menneking and Karl Wilhelm Lorenzini Dusseldorf, Kurt Horn, Oberndorf-Lindenhof, and Gerd Blaas, Mulheim, Baden, Germany, assignors to Firma Rheinmetall G.m.b.H., Dusseldorf, Germany, a corporation of Germany; Filed November 22, 1967, Serial No. 684,976; Claims priority, application Germany, November 26, 1966; 8 Claims; (Cl. 89–33).

3,507,186; **MAGAZINE FOR AUTOMATIC FIREARMS**; Jiri Cermak and Bohuslav Novotny, Brno, Czechoslovakia, assignors to Vyzkumny a vyvojovy ustav Zavodu vseobecnecho strojirenstvi, Brno, Czechoslovakia; Filed June 29, 1967, Serial No. 650,029; 5 Claims; (Cl. 89–34).

3,507,187; **BREECH MECHANISM**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques, S. A., Geneva, Switzerland, a society of Switzerland; Filed April 1, 1968, Serial No. 717,621; Claims priority application Luxemburg, June 30, 1967, 24 Claims; (Cl. 89–185).

May 5, 1970

3,509,654; **RIFLE MAGAZINE HAVING TRANSVERSELY ACTING SPRING MEANS THEREIN**; Ludwig Vorgrimler, Oberndorf (Neckar), Germany, assignor to Messrs. Mauser-Werke Aktiengesellschaft, Oberndorf (Neckar), Germany, a corporation of Germany; Filed December 5, 1957, Serial No. 688,083; Claims priority, application Germany, December 8, 1966, M 71,944; 3 Claims; (Cl. 42–6).

3,509,655; **PISTOL MAGAZINE FOLLOWER DEPRESSOR**; Gary Wilhelm, Hamden, Connecticut, assignor to Stoeger Arms Corporation, South Hackensack, New Jersey, a corporation of New Jersey, Filed March 22, 1968, Serial No. 715,284; 2 Claims; (Cl. 42–50).

3,509,791; **WEAPON FIRING SYSTEM INCLUDING A SEISMIC AND RADIATION RESPONSIVE CONTROL**; Jacques Pechamat and Henri Piazza, Toulouse, and Pierre Goubler, Blagnac, France, assignors to the French State represented by the Minister of Armed Forces, Ministerial Delegation of Weapons, Technical Delegation of Land Weapons, Manufacturing Workshops of Toulouse, Paris, France; Filed May 16, 1969, Serial No. 825,378; Claims priority, application France, May 17, 1968, 152,247; 8 Claims; (Cl. 89–135).

3,509,792; **BALL MOUNT, PARTICULARLY FOR ARMORED VEHICLES**; Walter Ruf, Landhaus am Sec, Bottinghofen, Thurgau, Switzerland; Filed July 3, 1968, Serial No. 742,409; Claims priority, application Austria, April 18, 1968, 11 Claims; (Cl. 89–37).

May 19, 1970

3,512,290; **FIREARM HOUSING ASSEMBLY HAVING THREE SECTIONS AND IN INTERLOCKING CENTRAL COUPLING MEMBER THEREFOR**; Paul A. LaViolette, Jr., and Edward M. Marino, North Haven, Connecticut, assignors to the High Standard Manufacturing Corporation, Hamden, Connecticut, a corporation of Connecticut; Filed July 8, 1968, Serial No. 743,099; 6 Claims; (Cl. 42–75).

3,512,449; **ACCELERATOR FOR THE BOLT CARRIER OF AN AUTOMATIC GUN**; Eugene M. Stoner, Rte. 1, Box 70, Port Clinton, Ohio 44216; Original application September 29, 1965, Serial No. 491,300, now Patent No. 3,455,204 dated July 15, 1969. Divided and this application July 22, 1968, Serial No. 763,447; 13 Claims; (Cl. 89–169).

May 26, 1970

3,513,581; **FLASHLIGHT ATTACHMENT FOR GUNS**; Olin Slater, 2412 Eagle Drive, Augusta, Georgia 30906; Filed June 4, 1968, Serial No. 734,425; 4 Claims; (Cl. 42–1).

June 2, 1970

3,514,888; **GUN BARREL OILING DEVICE**; Anthony Bramley, Gosford House, Gosford, Kidlington, Oxfordshire, England; Filed April 29, 1968, Serial No. 724,770; Claims priority, application Great Britain, May 5, 1967, 9 Claims; (Cl. 42–1).

3,514,889; **CUSHIONED FIREARM RECOIL PAD**; Frank A. Pachmayr, 1220 S. Grand Avenue, Los Angeles, California 90015; Filed April 15, 1968, Serial No. 721,361; 3 Claims; (Cl. 42–74).

June 23, 1970

3,516,189; **MAGAZINE WITH MOVABLE FEED LIPS AND GUIDE FINGERS**; Oliver N. Lewis, Woodbridge, and Joseph A. Badall, Branford, Connecticut, assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed April 19, 1968, Serial No. 722,772; 13 Claims; (Cl. 42–50).

3,516,326; **MORTAR BARREL**; Arno Sten Dooner, P. O. Box 10032, Helsinki, Finland; Filed April 12, 1968, Serial No. 720,838; Claims priority application France, April 27, 1967, 10 Claims; (Cl. 89–14).

June 30, 1970

3,517,585; **REINFORCED PLASTIC TUBE AND GUN BARREL CONSTRUCTION INCORPORATING AN IMBEDDED EXPANDABLE WOVEN SCREEN LINING**; Edwin Slade, 5700 Arlington Avenue, Bronx, New York 10471; Filed March 10, 1966, Serial No. 533,334; 11 Claims; (Cl. 39–16).

3,517,586; **AUTOMATIC GUN BUFFER ASSEMBLY**; Eugene M. Stoner, Rte. 1, Box 70, Port Clinton, Ohio 43452; Original application September 29, 1965, Serial No. 491,300, now Patent No. 3,455,204, dated July 15, 1969. Divided and this application July 22, 1968, Serial No. 763,448; 1 Claim; (Cl. 89–198).

July 14, 1970

3,520,226; **GUN BLAST DIFFUSER**; Robert H. Meadows, Edmundson, and Ronald E. Volker, St. Charles County, Missouri, assignors, by mesne assignments, to the United States of Amerca as represented by the Secretary of the Navy; Filed July 12, 1968, Serial No. 744,469; 1 Claim; (Cl. 89–14).

July 21, 1970

3,521,523; **AIR OPERATED PROJECTILE FIRING APPARATUS**; Jules Edmond Van Langenhoven, Benton County, Arkansas, by mesne assignment to Victor Comptometer Corporation, Chicago, Illinois, a corporation of Illinois, Application July 7, 1965, Serial No. 473,556, which is a continuation-in-part of application Serial No. 189,621, April 23, 1962. Divided and this application July 18, 1968, Serial No. 760,106; 7 Claims; (Cl. 89–7).

August 25, 1970

3,525,172; **RIFLED BORE CONSTRUCTION FOR A GUN BARREL**; Richard L. Marshall and Anthony A'Costa, Englewood, Colorado, assignors, by court decree, to A.I.M. Magnum Corporation; Continuation-in-part of application Serial No. 625,107, March 22, 1067. This application July 5, 1968, Serial No. 742,871; 8 Claims; (Cl. 42–78).

September 1, 1970

3,526,051; **LEVER OPERATED FIREARM BREECH MECHANISM WITH A PIVOTED BREECH BLOCK**; Charles G. Greco, Wilbraham, Massachusetts, and Walter Delis, Simsbury, Connecticut, assignors to Professional Industries, Inc., Agawam, Massachusetts, a corporation of Massachusetts; Filed August 13, 1968, Serial No. 752,202; 5 Claims; (Cl. 42–28).

September 8, 1970

3,527,137; **EXPENDABLE CASE AMMUNITION**; John H. Scanlon, Monroe, Connecticut, assignor to Remington Arms Company, Inc., Bridgeport, Connecticut, a corporation of Delaware; Continuation-in-part of application Serial No. 686,508, November 29, 1967, now Patent No. 3,485,170. This application December 24, 1968, Serial No. 786,597; 14 Claims; (Cl. 89–1).

September 15, 1970

3,528,187; **FREE-VOLUME CHAMBER FOR TELESCOPED CASELESS AMMUNITION**; Joseph I. Harrell, Sparta, New Jersey, assignor to Hercules Incorporated, Wilmington, Delaware, a corporation of Delaware; Filed October 23, 1968, Serial No. 769,908; 6 Claims; (Cl. 42–76).

3,528,336; **MUZZLE ASSEMBLY FOR SMOOTH-BORE PROJECTILES**; Fredrik Donner, Helsinki, Finland, assignor to Oy Tampella AB, Tampere, Finland; Filed March 27, 1968, Serial No. 716,519; Claims priority, application Germany, April 1, 1967, 2 Claims; (Cl. 89–14).

September 22, 1970

3,529,509; **AMMUNITION HANDLING SYSTEM FOR DISPENSING DISCRETE ROUNDS AND GUN SYSTEM EMBODYING SAME**; Ivan N. Vuceta, Los Angeles, California, assignor to TRW Inc., Redondo Beach, California, a corporation of Ohio; Filed June 12, 1968, Serial No. 736,509; 2 Claims; (Cl. 89–33).

September 29, 1970

3,530,609; **BREECH LOCKING MECHANISM FOR BREAK-ACTION OVER AND UNDER FIREARM**; Ralph E. Staggs, 4801 E. Palomino Road, Phoenix, Arizona, 85018; Filed July 29, 1968, Serial No. 748,527; 12 Claims; (Cl. 42–33).

3,530,762; **AIR OPERATED PROJECTILE FIRING APPARATUS**; William Harold Batie, Rogers, Arkansas; Glenn Clark Smith, Rogers, Arkansas; and Robert Keith Marshall, Rogers, Arkansas; assignors, by mesne assignments, to Victor Comptometer Corporation, Chicago, Illinois, a corporation of Illinois; Continuation of application Serial No. 469,987, July 7, 1965. This application November 14, 1967, Serial No. 683,029; 3 Claims; (Cl. 89–7).

October 6, 1970

3,531,886; **FIREARM HAMMER**; Edwin S. Vartanian, North Haven, and Jay P. Jarvis, West North Branford, Connecticut, assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed May 29, 1968, Serial No. 732,989; 4 Claims; (Cl. 42–69).

October 13, 1970

3,533,325; **STRIPPER SHREDDER FOR FRANGIBLE SABOTS**; Irwin R. Barr, Lutherville, Maryland, assignor to AAI Corporation, Cockeysville, Maryland, a corporation of Maryland; Continuation of application Serial No. 606,387, December 30, 1966, now abandoned. This application February 14, 1969, Serial No. 801,243; 9 Claims; (Cl. 89–14).

October 20, 1970

3,534,492; **FIREARM GRENADE LAUNCHING ATTACHMENT**; Stanley A. Amster, Pittsburgh, Pennsylvania, assignor to Federal Laboratories, Inc., Saltsburg, Pennsylvania, a corporation of Delaware; Filed November 14, 1968, Serial No. 775,815; 6 Claims; (Cl. 42–1).

October 27, 1970

3,535,809; **FIRING EQUIPMENT FOR SIMULATING GUNFIRE**; Oswald Hoffmann, Lintorf, Bezirk Dusseldorf, Germany, assignor to Firma Hoffmann-Werke J. Oswald Hoffmann, Lintorf, Bezirk Dusseldorf, Germany; Filed February 2, 1968; Serial No. 702,607; 2 Claims (Cl. 42–1).

3,535,979; **SELF COCKING SPRING STARTER AND BRAKE**; Eugene Ashley, Burlington, Vermont and Douglas P. Tassie, St. George, Vermont, assignors to General Electric Company, a corporation of New York; Filed September 18, 1968; Serial No. 760,490; 12 Claims (Cl. 89-1).

3,535,980; **AUTOMATIC, BURST FIRING, GUN**; Robert E. Chiabrandy and George H. Bloom, Burlington, Vermont, assignors to General Electric Company, a corporation of New York; Filed December 26, 1968; Serial No. 787,069; 7 Claims (Cl. 89–47).

November 3, 1970

3,537,203; **MULTIPLE BARREL FIREARM HAVING BARREL SELECTION MEANS RESPONSIVE TO COUNTER RECOIL**; Roy E. Weatherby, 7549 E. 4th Place, Downey, Calif.,90241 and Fred L. Jennie, Buena Park, California; said Jennie assignor to said Weatherby; Filed April 10, 1968; Serial No. 720,228; 11 Claims (Cl. 42–42).

3,537,204; **SAFETY MECHANISM AND STOP MEMBER FOR A CYLINDER SLIDE RELEASE**; David S. Woloch, 522 Overwood Road, Akron, Ohio 44313; Filed August 8, 1968; Serial No. 751,148; 2 Claims (Cl. 42–66).

3,537,352; **AIR IGNITION GUN**; Ronald Wayne Joyce, Springdale, Arkansas, assignor to Victor Comptometer Corporation, Chicago, Illinois a corporation of Illinois; Filed July 25, 1968; Serial No. 754,133; 2 Claims (Cl. 89–7).

3,537,353; **CIRCUIT FOR AUTOMATICALLY OPERATING THE BREECH OF A LARGE CALIBER GUN**; Robert E. Nelson, Indianapolis, Indiana, assignor to General Motors Corporation, Detroit, Michigan a Corporation of Delaware; Filed August 21, 1968; Serial No. 754,320; 5 Claims (Cl. 89–135).

November 10, 1970

3,538,635; **COMBINED EXTRACTOR AND EJECTOR MECHANISM FOR AUTOMATIC GRENADE LAUNCHER**; Harvey H. Friend, Hamden, Conn., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed December 26, 1968; Serial No. 787,008; 14 Claims (Cl. 42–10).

3,538,636; **RESILIENT CARTRIDGE HOLDER HAVING AN ELONGATED BASE CONTAINING A PLURALITY OF CARTRIDGE-RECEIVING RECESSES**; Sam W. Roth, 743 Vista Drive, Redwood City, California 94062; Filed July 18, 1968; Serial No. 745,840; 1 Claim (Cl. 42–87).

3,538,810; **BARREL ATTACHMENT FOR A FIREARM**; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Original application April 1, 1968; Serial No. 717,524; now Patent No. 3,447,418, dated June 3, 1969. Divided and this application October 21, 1968; Serial No. 810,862; 7 Claims (Cl. 89–159).

3,538,811; **DOUBLE ACTING BOLT-SLIDE COUPLING BUFFER**; David A. Poole, Groton, Connecticut and Frederick P. Reed, Davenport, Iowa, assignors to The United States of America, as represented by the Secretary of the Army; Filed October 23, 1968; Serial No. 769,984; 9 Claims (Cl. 89–198).

November 17, 1970

3,540,141; **REPEATING MECHANISM FOR IMPACT IGNITION PELLETS**; David F. Butler, Hamden, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed October 25, 1968; Serial No. 770,755; 2 Claims (Cl. 42–17).

3,540,142; **BOLT STOP MECHANISM**; Edwin S. Vartanian, North Haven, Conn., and William J. Billett, Fairmont, Minn., assignors to Olin Mathieson Chemical Corporation, a corporation of Virginia; Filed September 25, 1968; Serial No. 762,594; 6 Claims (Cl. 42–22).

3,540,147; **BREECH BOLT LOCKING MEANS COMPRISING A RESILIENT SPLIT RING HAVING LOCKING LUGS THEREON**; Douglas S. Cream and Joyce S. Cream, both of 107 Delsan Court, Buffalo, N. Y. 14216; Filed July 25, 1968; Serial No. 747,538; 5 Claims (Cl. 42–16).

3,540,345; **AMMUNITION FEED FOR A MACHINE GUN**; Baron C. Wolfe, P. O. Box X, Eureka, California 95501; Filed June 5, 1968; Serial No. 734,773; 2 Claims (Cl. 89–13).

November 24, 1970

3,541,715; **AUTOMATIC REPEATING FIREARM HAVING A MAGAZINE TRANSFER PORT AND CLOSURE MEANS THEREFOR**; Nicolaos Lagos, 314 Seaton St., Toronto 2, Ontario, Canada; Filed July 1, 1968; Serial No. 741,785; 10 Claims (Cl. 42–17).

3,541,716; **RAPID REVOLVER LOADER**; John Dees Fordham, 767 W. 32nd Street, Hialeah, Florida 33516, and William Lee Powers, 1260 NE. 214th Street, North Miami Beach, Fla. 33162; Filed January 28, 1969; Serial No. 794,521; 10 Claims (Cl. 42–89).

3,541,920; **SPRING URGED IGNITABLE ACTUATING ELEMENT**; Reinhold Rapp, Stadeln, Heinz Gawlick, Furth and Hellmut Bendler, Nurnberg, Germany, assignors to Dynamit Novel Aktiengesellschaft, Troisdorf, Germany; Filed April 8, 1968; Serial No. 719,652; 7 Claims (Cl. 89–1).

December 1, 1970

3,543,427; **AIR OPERATED PROJECTILE FIRING APPARATUS**; Ronald W. Joyce, Springdale, Eugene E. Billingslea, Rogers, Leopold C. Sage, Fayetteville, and Robert K. Marshall, Rogers, Arkansas, assignors to Victor Comptometer Corporation, Chicago, Ill., a corporation of Illinois Application March 29, 1968; Serial No. 739,575, now Patent No. 3,497,984, dated March 3, 1970, which is a division of application Serial No. 598,087, November 30, 1966. Divided and this application April 3, 1969; Serial No. 815,257; 6 Claims (Cl. 42–39.5).

3,543,428; **RIFLE FORESTOCK**; George A. Bronson, West Sacramento, Calif. (P. O. Box 588, Sacramento, California 95803); Filed March 29, 1968; Serial No. 717,163; 6 Claims (Cl. 42–71).

3,543,429; **KITS FOR ADAPTING OLD PERCUSSION REVOLVERS TO FIRE MODERN CARTRIDGES**; Paul Bendele, 14 Rue d'Illkirch, Ostwald, Bas-Rhin, France, and Gilles Merklen, 25 Rue de Bourgogne, Strasbourg-Meinau, France; Filed May 8, 1968; Serial No. 727,504; Claims priority, application Italy, May 10, 1967, 6,996/67, Patent 807,597; 2 Claims (Cl. 42–77).

December 8, 1970

3,545,116; **FIREARM WITH AN ANGULARLY INDEXED FIRING PIN AND NONROTATABLE MAGAZINE**; Charles E. Babington, 35 Locust Drive, Springboro, Ohio 45066; Filed August 9, 1968; Serial No. 751,511; 17 Claims (Cl. 42–1).

3,545,117; **MULTISHOT UNDERWATER POWER HEAD**; Steven C. Van Voorhees, Box 1107, Ormond Beach, Florida 32074; Filed November 8, 1968; Serial No. 774,373; 8 Claims (Cl. 42–59).

December 15, 1970

3,546,803; **TARGET FIREARM WITH BLOW BACK BREECH BOLT AND SAFETY LATCH THEREFOR**; Bernard H. Swanson, 903 Queens Lane, Anoka, Minn. 55302, and John T. Walker, 2205 Long Lake Road, St. Paul, Minn. 55112; Filed August 7, 1968; Serial No. 750,953; 8 Claims (Cl. 42).

3,547,001; **GUN FOR CASELESS AMMUNITION IN WHICH A SLIDABLE SLEEVE DEFINES THE CHAMBER**; Eugene M. Stoner, Port Clinton, Ohio, assignor to TRW, Inc.; Filed June 13, 1968; Serial Number 736,705; 16 Cliams; (Cl. 89–156).

December 22, 1970

3,548,530; **REVOLVER FIRING MECHANISM HAVING A DIE-CAST HAMMER AND TRIGGER WITH STEEL INSERTS EMBEDDED THEREIN**; Gunter Horst Rohm, Sontheim an der Brenz, Germany, assignor to Rohm-Gesselschaft m.b.H. Werkzeur- und Maschinenfabrik, Sontheim an der Brenz, Germany; Filed June 4, 1968; Serial No. 734,325; Claims priority, application Germany, March 9, 1968; 7 Claims (Cl. 42–65).

3,548,709; **FIRING MECHANISM FOR AUTOMATIC GRENADE LAUNCHER**; Marshall D. Prince, Tustin, California, assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; 8 Claims (Cl. 89–149).

December 29, 1970

3,550,300; **FIREARM WITH TWO OR MORE ADJUSTABLE BARRELS**; Philipp Roder, Kutzerstrasse 37, Furth, Bavaria, Germany; Filed July 22, 1968; Serial No. 746,380; Claims priority, application Germany, February 8, 1968, R 47,969; 9 Claims (Cl. 42–1).

3,550,301; **TRIGGER MECHANISM FOR SPORTING GUNS**; Alexandr Sergeevich Shesterikov, Ulitsa Pushkinskaya 244, kv. 35, Izhevsk, U.S.S.R.; Filed July 12, 1968; Serial No. 744,521; 6 Claims (Cl. 42–69).

3,550,500; **FIRING MECHANISM**; Chao H. Lin, Madison, Ill., assignor to Olin Corporation, a corporation of Virginia; Filed November 26, 1968; Serial No. 779,156; 10 Claims (Cl. 89–1).

3,550,502; **BREECH END SECTION OF LINED GUN BARREL**; George H. Keith, East Orange, N. J., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Army; Filed September 1, 1955; Serial No. 532,128; 1 Claim (Cl. 89–16).

January 5, 1971

3,552,053; MEANS FOR COUNTING SHOTS FIRED FROM A GUN; Kenneth W. Jarvis, Old Lyme, Conn., assignor to General Time Corporation, Stamford, Conn., a corporation of Delaware; Filed February 24, 1969; Serial No. 801,421; Int. Cl. F41C 27/100; (U.S. Cl. 42–1).

January 12, 1971

3,553,876; UNDERWATER GUN; Alfred Engler, 1020 N.E. 196th Terrace, North Miami Beach, Fla. 33162; Filed February 20, 1969; Serial No. 801,002; (U.S. Cl. 42–1).

3,553,877; SAFETY LOCK FOR FIREARMS; Nicholas A. Welch, West Hartford, Conn., and Joseph R. Ferrara, Agawam, Mass., assignors to Emhart Corporation, Bloomfield, Conn., a corporation of Connecticut; Filed June 28, 1968; Serial No. 741,098; 8 Claims (U.S. Cl. 42–70).

3,553,878; MEANS FOR SUPPORTING AND AIMING A HAND-HELD DEVICE; Jack Y. Canon, 2194 Delmus, Opelousas, La. 70570; Filed July 23, 1968; Serial No. 746,895; 15 Claims (U.S. Cl. 42–94).

3,554,077; DELAY BLOWBACK MECHANISM FOR FIREARMS; Harold A. Schlapia, Jr., 1258 N. Fuller Ave., West Hollywood, Calif.; Filed April 21, 1969; Serial No. 817,844; 4 Claims (U.S. Cl. 89–194).

3,554,078; SPHERICAL MISSILE AND LAUNCHING MEANS THEREFOR; Joseph S. Horvath, 2747 McAllister St., Riverside, Calif.; Continuation-in-part of application; Serial No. 671,284, September 28, 2967, now abandoned. This application February 10, 1969; Serial No. 797,903; 11 Claims (U.S. Cl. 89–1.808).

January 26, 1971

3,557,481; FIREARM MOUNTED IN A SHOE HEEL; Fred E. Stuart, Sr., 1157 Bel Aire Drive, P. O. Box 5856, Daytona Beach, Fla. 32018; Filed September 12, 1968; Serial No. 759,445; 8 Claims (U.S. Cl. 42–1).

3,557,482; MEANS FOR CONTROLLING THE HEADSPACING OF GRENADE CARTRIDGES IN A SINGLE-SHOT LAUNCHER; Robert L. Hoover, Royal Oak, Mich., assignor, by mesne assignments to the United States of America as represented by the Secretary of the Army; Filed February 4, 1969; Serial No. 796,366; 10 Claims (U.S. Cl. 42–12).

3,557,485; SWIVEL ASSEMBLY; Paul D. Williams, Davidson, Mich., assignor to Williams Gun Sight Co., Davidson, Mich., a corporation of Michigan; Filed October 14, 1968; Serial No. 767,266; 10 Claims (U.S. Cl. 42–85).

February 2, 1971

3,559,527; ARMORED COMBAT VEHICLE; Hans-Georg Schallehn, Kassel, Germany, assignor to Rheinstahl Henschel A. G., Kassel, Germany, a corporation of Germany; Filed November 15, 1967; Serial No. 683,320; Claims priority, application Germany, December 9, 1966, R44761; 9 Claims (U.S. Cl. 89–36).

3,559,528; WEAPONS SYSTEM FOR MOTOR VEHICLES; Zed Cunningham, 4104 Green Court, Cleveland, Ohio; Filed October 27, 1969; Serial No. 869,809; 2 Claims (U.S. Cl. 89–40).

February 9, 1971

3,561,148; EJECTION SYSTEM FOR A FIREARM; Bernard Maillard, Geneva, Switerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland, a society of Switzerland; Original application April 1, 1968; Serial No. 717,524, now Patent No. 3,447,418, dated June 3, 1969. Divided and this application October 21, 1968; Serial No. 810,863; Claims priority, application Luxemburg, July 31, 1967, 54,210; 1 Claim (U.S. Cl. 42–25).

3,561,149; PISTOL WITH MEANS ACTUATING THE BARREL LATCH AND SETTING THE TRIGGER MECHANISM AND SAFETY; Warren A. Center, Laurel Drive, Westminster, Mass. 01473; Filed October 9, 1968; Serial No. 766,156; 9 Claims (U.S. Cl. 42–41).

3,561,319; AIR-OPERATED PROJECTILE FIRING APPARATUS; Ronald W. Joyce, Springdale, and Jules Edmond Van Langenhoven, Rogers, Ark., assignors to Victor Comptometer Corporation, Chicago, Illinois; Filed July 7, 1965; Serial No. 469,992; 22 Claims (&.S. Cl. 89–7)

February 16, 1971

3,562,944; RIFEL WITH DETACHABLE MAGAZINE AND LATCH THEREFOR; Karl wagner and Horst Wesp, Steyr, Austria, assignors to Steyr-Daimler-Puch Aktiengesellschaft, Vienna, Austria; Filed March 4, 1969; Serial No. 804,116; Claims priority, application Austria, April 3, 1968,6 Claims (U.S. Cl. 42–6).

3,562,945; GUN BARREL WITH STEPPED RIFLING; Leo David Mikola, Lopentie 10, Riihimaki, Finland; Filed October 14, 1968; Serial No. 767,225; Claims priority, application Finland, October 17, 1967, 5 Claims (U.S. Cl. 42–78).

3,563,132; GRENADE LAUNCHER; Walter R. Cashen, Louisville, and George M. Chinn, Harrodsburg, Ky., and William P. Schnatter, Jeffersonville, Ind., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy; Filed September 19, 1968; Serial No. 760,936; 1 Claim (U.S. Cl. 89–33).

3,564,746; MAIN-SPRING RELEASING ACCESSORY FOR FIREARMS; Elbert E. McConnell, 80 Church Street, Merrimac, Mass. 01860; Filed March 28, 1969; Serial No. 811,355; 6 Claims (U.S. Cl. 42–1).

3,564,747; **LOADER TO CONVERT SINGLE-FIRE BOLT-LOADING FIREARMS TO REPEATERS**;Hector Mendoza Orozco, Bartolache 1914, Mexico City 21, Mexico; Filed October 8, 1968; Serial No. 776,297; 10 Claims (U.S. Cl. 42–18).

3,564,967; **PISTOL BARREL POSITIONING MEANS**; Paul A. La Violette, North Haven, and Ralph C. Kennedy, Wapping, Conn., assignors to Colt's Inc., Hartford, Conn.; Filed September 9, 1968; Serial No. 758,223; 8 Claims (U.S. Cl. 89–163).

March 2, 1971

3,566,527; **EMERGENCY FIREARM FIRING MECHANISM FOR HIGH VELOCITY GRENADE ROUNDS**;Stanley D. Silsby, Granby, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed December 6, 1968; Serial No. 781,738; 7 Claims (U.S. Cl. 42–41).

3,566,528; **GUN BARREL**; C. Walton Musser, Beverly, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed April 23, 1958; Serial No. 731,078; 3 Claims (U.S. Cl. 42-78).

3,566,740; **VELOCITY SENSOR FIRING MECHANISM FOR ARTILLERY WEAPONS**; Jimmy H. Williams, Bettendorf, Iowa, and Lawrence L. Frauen, Moline, Ill.; Filed May 28, 1969; Serial No. 828,561; 18 Claims (U.S. Cl. 89–27).

3,566,742; **ARMORED VEHICLE HAVING MEANS FOR INTERCHANGEABILITY TOP MOUNTED WEAPONRY**; James M. Bemiss, St. Clair Shores, Mich., assignor to Cadillac Cage Company, Warren, Michigan; Continuation-in-part of application Serial No. 740,961, June 28, 1968. This application August 27, 1969; Serial No. 858,251; 1 Claim (U.S. Cl. 89–40).

3,566,743; **KINEMATIC DEVICE FOR FIRE CONTROL AGAINST TERRESTRIAL TARGETS WITH SINGLE RATE SENSOR**; Millard M. Frohock, Jr., Thousand Oaks, Calif., assignor to Hughes Aircraft Company, Culver City, Calif.; Filed August 21, 1968; Serial No. 754,408; 5 Claims (U.S. Cl. 89–41).

3,566,744; **AUTOMATIC GUN RECEIVER COMBINATION**; Eugene M. Stoner, Route 1, Box 70, Port Clinton, Ohio; Continuation of application Serial No. 763,449, July 22, 1968, now abandoned, which is a division of application Serial No. 491,300, September 29, 1965, now Patent No. 3,455,204. This application July 14, 1969; Serial No. 854,005; 11 Claims (U.S. Cl. 89–125).

3,566,745; **AUTOMATIC FIREARM BIPARTITE SEMIRIGID BOLT**; Stanly Jauch, Welden uber Horb, and Herbert Meidel, Oberndorf, Germany, assignors to Heckler & Koch GmbH, Oberndorf (Neckar), Germany; Filed October 25, 1968; Serial No. 770,648; Claims priority, application Germany, October 28, 1967, 11 Claims (U.S. Cl. 89–187).

March 3, 1971

3,568,348; **FIREARM MAGAZINE CATCH**; Gary Wilhelm, Hamden, Conn., assignor to Stoeger Arms Corporation, South Hackensack, N. J.; Filed June 25, 1968; Serial No. 739,816; 2 Claims (U.S. Cl. 42–7).

3,568,349; **TRIGGER-OPERATED MAGAZINE INDEXING MEANS FOR A SEMIAUTOMATIC GRENADE LAUNCHER**; Charles E. Lanizzani, Davenport, Iowa, assignor to the United States of America as represented by the Secretary of the Army; Filed May 12, 1969; Serial No. 823,891; 14 Claims (U.S. Cl. 42–39.5).

3,568,350; **EMERGENCY FIREARM**; Stanley D. Silsby, Granby, Mass., assignor to the United States of America as represented by the Secretary of the Army; Filed December 17, 1968; Serial No. 784,397; 5 Claims (U.S. Cl. 42–75).

March 9, 1971

3,568,563; **GAS DRIVE FOR A WEAPON HAVING A ROTATING CLUSTER OF BARRELS**; Lawrence R. Folson, Charlotte, Vermont, assignor to General Electric Company; Filed January 2, 1969; Serial No. 788,404; 7 Claims (U.S. Cl. 89–126).

3,568,564; **SHOTGUN SHORT STROKE GAS SYSTEM**; Joseph A. Badall, Branford, Conn., assignor to Olin Corporation; Filed September 30, 1968; Serial No. 763,566; 5 Claims (U.S. Cl. 89–191).

3,568,565; **BUFFER DEVICE WITH ENERGY DISCHARGE MEANS**; Henry P. Swieskowski, Bettendorf, Iowa, Administration the United States of America, as represented by the Secretary of the Army; Filed November 25, 1968; Serial No. 778,490; 8 Claims (U.S. Cl. 89–198).

March 16, 1971

3,570,161; **BLOCKING BOLT SAFETY DEVICE**; Herbert J. Nordhauser, Box 8652, Albany, N. Y. 12208; Filed August 2, 1967; Serial No. 657,982; 2 Claims (U.S. Cl. 42–70).

3,570,162; **TELESCOPING AUXILIARY GUN STOCK ATTACHMENT FOR FIREARMS**; Jack Suddarth, Comins, Michigan 48619; Filed November 26, 1968; Serial No. 778,967; 10 Claims (U.S. Cl. 42–72)

3,570,365; **BALLISTIC DEVICE COMPRISING A PROJECTILE AND ITS LAUNCHER**; Robert Bornand, Meyrin, Switzerland, assignor to Transurvey Holding Company, Inc., Societad Anonima, Panama; Filed April 11, 1969; Serial No. 815,340; Claims priority, application Switzerland, April 11, 1968, 9 Claims (U.S. Cl. 89–1).

3,570,366; **DEVICE FOR DISABLING FIREARM ACTION ON CARTRIDGE FEED INTERRUPTION THERETO**; Ewald F. Nickel, New Haven, Conn., assignor to The Martin Firearms Company, New Haven, Conn.; Filed July 1, 1969; Serial No. 838,289; 16 Claims (U.S. Cl. 89–138).

3,571,961; FIRING MECHANISM WITH A REARWARDLY ACTIVATED FIRING PIN; Joel Lehtinen, Karhula, Jumalniemi, Finland, assignor to Oy Sako AB, Riihimaki, Finland; Filed October 7, 1968; Serial No. 765,433; 10 Claims (U.S. Cl. 42–69).

3,571,962; MONOLITHIC METALLIC LINER FOR FIBERGLASS GUN TUBES; Merrill Eig, Parsippany, New Jersey, assignor to the United States of America as represented by the Secretary of the Army; Filed June 10, 1969; Serial No. 831,876; 10 Claims (U.S. Cl. 42–76).

April 13, 1971

3,574,264; MAGAZINE ASSEMBLY FOR AUTOMATIC RIFLES; Ernest P. Simmons, Sr., Olathe, Kansas 66061; Filed July 14, 1969; Serial No. 841,396; 4 Claims (U.S. Cl. 42–6).

3,574,965; PROTECTIVE COVER MEANS FOR FIREARMS; Richard H. Seiger, 5525 Hillside Drive, Salt Lake, Utah; Filed January 23, 1969; Serial No. 793,393; 7 Claims (U.S. Cl. 42–1).

3,575,085; ADVANCED FIRE-CONTROL SYSTEM; William E. McAdam, Jr., Thousand Oaks, Calif., assignor to Hughes Aircraft Company, Culver City, Calif.; Filed August 21, 1968; Serial No. 754,344; 36 Claims (U.S. Cl. 89–41R).

April 27, 1971

3,576,084; ADJUSTABLE GUN REST; William B. Anderson, Jr., 551 Fletcher Road, Wayne, Pa.; Filed May 16, 1969; Serial No. 825,351; 7 Claims (U.S. Cl. 42–94)

May 4, 1971

3,577,667; LOCK FOR PERCUSSION CAP RIFLE; Robert P. Kern, 319 E. Main Street, Ligonier, Pa., and Allen J. Hamm, 251 McKimm Drive, Pittsburgh, Pa.; Filed October 29, 1968; Serial No. 771,411; 5 Claims (U.S. Cl. 42–69).

3,577,668; TRIGGER AND SAFETY ASSEMBLY FOR FIREARMS; William B. Ruger, Southport, Conn., and Leroy J. Sullivan, Huntington Beach, Calif., assignors to Sturm, Ruger & Co., Inc., Southport, Conn.; Filed July 22, 1969; Serial No. 843,385; 9 Claims (U.S. Cl. 42–70E).

3,577,826; BELLOWS SEALED FIRING PIN; Eugene Ashley, Burlington, and Douglas Pray Tassie, St. George, Vermont, assignors to General Electric Company; Filed July 22, 1969; Serial No. 843,728; 12 Claims (U.S. Cl. 89–26).

3,577,827; TRIGGER MECHANISM; William J. Billett, Fairmont, Minn., and Edwin S. Vartanian, North Haven, Conn., assignors to Olin Mathieson Chemical Corporation; Filed January 27, 1969; Serial No. 793,958; 11 Claims (U.S. Cl. 89–145).

May 11, 1971

3,577,860; MAGAZINE FOR FIREARMS; Leopold Jestrabek, Oberndorf (Neckar), Germany, assignor to Heckler & Koch GmbH, Oberndorf (Neckar), Germany; Filed July 8, 1968; Serial No. 743,158; Claims priority, application Germany, May 4, 1968, 8 Claims (U.S. Cl. 42–50).

May 25. 1971

3,579,891; SINGLE SELECTIVE TRIGGER SYSTEM FOR DOUBLE BARREL FIREARMS; John J. Kuzma, North Haven, and Robert I. Gawrych, Killingworth, Conn., assignors to Olin Mathieson Chemical Corporation; Filed February 14, 1969; Serial No. 799,217; 2 Claims (U.S. Cl. 42–42)

3,580,113; ELECTRICAL IGNITION FIREARM, WITH A FORWARDLY SLIDING BARREL; Marcus Ramsay, New Haven, Conn., and Arthur W. Lilley, Pittsburgh, Pa., assignors to Olin Corporation; Filed September 12, 1969; Serial No. 857,366; 9 Claims (U.S. Cl. 42–84).

3,580,130; BULLET TRAP ATTACHMENT FOR MACHINE GUNS; Paul W. Arvidson, Princeton, Iowa; William G. Park, Silvis, Illinois, and Keith S. Williams, Davenport, Iowa assignors to The United States of America as represented by the Secretary of the Army; Filed September 29, 1969; Serial No. 861,691; 8 Claims (U.S. Cl. 89–31).

3,580,131; ANTIFEEDBACK DEVICE; John R. Zimmerman, Sterling Heights, Mich., assignor to the United States of America as represented by the Secretary of the Army; Filed October 20, 1969; Serial No. 867,614; 4 Claims (U.S. Cl. 89–34).

3,580,132; BUFFER AND DELAY MECHANISM FOR A FIREARM; Edwin S. Vartanian, North Haven, Conn., assignor to Olin Mathieson Chemical Corporation; Filed September 25, 1968; Serial No. 762,593; 7 Claims (U.S. Cl. 89–130).

June 1, 1971

3,581,621; ARMORED VEHICLE TURRET; Russell E. Bauer, Grosse Pointe, Mich., assignor to KDI-Bauer Corporation, Warren, Mich.; Filed July 19, 1968; Serial No. 746,130; 6 Claims (U.S. Cl. 89–36).

June 8, 1971

3,583,087; LINE THROWING GUN AND CARTRIDGE; George W. Huebner, Middlefield, Conn. (c/o Harrington & Richardson Inc., 320 Park Ave., Worcester, Mass. 01610). Continuation in part of abandoned application Serial Number 704,418; February 9, 1968. This application October 22, 1969; Serial Number 871,454; 4 Claims. (Cl. 42–1).

3,583,088; **HANDGUN FIRING MECHANISM AND SAFETY THEREFOR**; Gert Buck, Bad Reichenhall; Erwin Niessner, and Rudiger Van Acken, Nuenburg, all of Germany, assignors to Messrs. Buck K. G., Bad Reichenhall, Germany; Filed March 13, 1969. Serial Number 807,014; Claims priority, application Germany, March 14, 1968; 5 Claims. (Cl. 42–70).

June 15, 1971

3,584,532; **AUTOMATIC GUN WITH EJECTION ACTUATED RAMMER**; Eugene M. Stoner, Port Clinton, and George W. Wight, Jr., Oak Harbor, both of Ohio, assicnors to Oberlikon-Buehrle Holding A. G. Zurich-Oerlikon, Zurich, Switzerland, Filed September 16, 1969. Serial Number 858,398; 17 Claims. (Cl. 89–47).

3,584,533; **AUTOLOADING FIREARM OF THE BLOWBACK TYPE**; Harond D. Allyn, 10 Sumner Ave., Springfield, Mass.; Filed January 21, 1969; Serial Number 792,694; 5 Claims. (Cl. 89–144).

June 29, 1971

3,589,051; **CARTRIDGE CHAMBER AND BREECH UNIT FOR RIFLES**; Augustin Necas, Prague, Czechoslovakia; assignor to Brno Zbrojobka, narodnl podnik, Brno, Czechoslovakis; Filed March 13, 1969; Serial Number 807,017; Claims priority, application Czechoslovakia, March 23, 1968; 7 Claims. (Cl. 43–32).

July 6, 1971

3,590,512; **AIR-OPERATED PROJECTILE-FIRING APPARATUS**; Ronald W. Joyce, Springdale; Eugene Billingslea, Rogers; Leopold C. Sage, Fayetteville, and Roberr K. Marshall, Rogers, all of Arkansas; assignors to Victor Comptometer Corporation, Chicago, Ill.; Division of Serial Number 739,575; March 29, 1968; which is a division of application Serial Number 598,087; November 30, 1966; Now Patent Number 3,399,596; Filed April 3, 1969; Serial Number 815,256; 4 Claims. (Cl. 42–39.5).

3,590,684; **AMMUNITION SUPPLY MEANS**; Kenneth J. Gilbert, Florissant, Mo.; assignor to Emerson Electric Co., St. Louis, Mo.; Filed April 18, 1969; Serial Number 817,305; 15 Claims. (Cl. 89–34).

3,590,685; **MOBILE REVETMENT**; Frank B. Lane, Dayton, Ohio; assignor to United Aircraft Products, Inc., Dayton, Ohio; Filed February 19, 1969, Serial Number 800,564; 10 Claims. (Cl. 89–36GI.

July 13, 1971

3,592,101; **GAS SYSTEM FOR AUTOLOADING FIREARM**; Edwin S. Vartanian, North Haven, and Jay Pl Jarvis, Madison, both of Conn.; assignors to Olin Corporation; Filed April 21, 1969; Serial Number 817,770; 7 Claims. (Cl. 89–193).

July 20, 1971

3,593,451; **PROTECTORS FOR FIREARM MUZZLES**; John J. McDonnell, 1245 Broadway, Rensselaer, N.Y.; Filed November 27, 1968; Serial Number 779,520; 1 Claim. (Cl. 42–1N)

3,593,452; **BOLT STOP FOR FIREARMS**; Roger M. Pekarek, West Simsbury, Conn.; assignor to Colt's Inc., Hartford, Conn.; Filed August 18, 1969; Serial Number 850,932; 3 Claims. (Cl. 42–16F).

July 27, 1971

3,595,128; **BOLT ASSEMBLY**; John P. Hoyt, Jr., Burlington, Vt.; assignor to General Electric Company; Filed October 22, 1969, Serial Number 868,380; 9 Claims. (Cl. 89–12).

3,595,129; **VARIABLE RATE SINUSOIDAL ACTION MACHINE GUN**; Jack N. Bender, 3089 A. Concord, Hill AFB, Utah, and Raymond Lashley, Box 88, Rte. 1, Hooper Utah, Filed November 5, 1969, Serial Number 874,195; 1 Claim. (Cl. 89–130).

August 3, 1971

3,596,555; **FIRING CHAMBER SEAL**; Duane A. Somers, Port Clinton; Edward S. Daniels, Port Clinton, and William E. Lahey, Oakharbor, all of Ohio; assignors to TRW Inc., Cleveland, Ohio; Filed May 5, 1969, Serial Number 821,639; 2 Claims. (Cl. 89–26).

3,596,556; **FEEDER DRIVE**; Alfred L. Montana, East Longmeadow, Mass.; assginor to General Electric Company; Filed April 7, 1969; Serial Number 814,094; 9 Claims. (CL 89–33 SF).

3,596,557; **POSITIONING DEVICE FOR CORRECTING MISLINKED AMMUNITION**; Robert W. Henshaw, Shelburne, Vt.; assignor to General Electric Company; Filed January 2, 1968; Serial Number 695,145; 6 Claims. (Cl. 89–33).

August 10, 1971

3,597,870; **MULTIPLE-BARREL HAND WEAPON WITH SELECTIVE BARREL DISCHARGE CAPABILITY**; Myron J. Block, Nahant, Mass.; assignor to Block Engineering, Inc., Cambridge, Mass.; Filed June 25, 1969; Serial Number 836,279; 2 Claims. (Cl. 42–42 R)

3,598,016; **AUTOMATIC BURST FIRING GUN HAVING REVOLVING CHAMBERS**; Robert Ernest Chiabrandy; John Leonard Amidon, and James Dexter Scanlon, all of Burlington, Vt.; assignors to General Electric Company; Filed March 18, 1969; Serial Number 808,155; 11 Claims. (Cl. 89–157).

3,559,530; AUTOMATIC REPLENISHER FOR THE HYDROPNEUMATIC RECOIL SYSTEMS OF LARGE CALIBER GUNS; Robert E. Seamands, Moline, Ill., and Elmer J. Henning, Bettendorf, Iowa, assignors to the United States of America as represented by the Secretary of the Army; Filed November 19, 1969; Serial Number 878,121; 4 Claims. (Cl. 89–43 R).

August 24, 1971

3,601,001; ARRANGEMENTS FOR GUIDING CARTRIDGE BELTS; Erich Jenny, Dubendorf, Switzerland, assignor to Werkzeugmaschinenfabrik Oerlikon-Buhrle AG, Zurich, Switzerland; Filed September 22, 1969; Serial Number 859,735; 4 Claims. (Cl. 89–33 BB)

3,601,002; GAS PISTON FOR SHOTGUN; Stefan Kenneth Janson, New Haven, Conn.; assignor to Olin Mathieson Chemical corporation; Filed February 14, 1969; Serial Number 799,380; 7 Claims. (Cl. 89–191).

August 31, 1971

3,601,918; FIRING PIN SAFETY MECHANISM; Dieter Keppeler, Ulm Donau, Germany; assignor to Carl Walther Sportwaffenfabrik; Filed January 22, 1970; Serial Number 4,899; 5 Claims. (Cl. 42–70 F).

3,602,086; AIR IGNITION SYSTEM AMMUNITION; Eugene E. Billingslea; Richard I. Daniel, and Claude A. Shope, all of Rogers, Arkansas; assignors to Victor Comptometer Corporation, Chicago, Ill.; by said Billingslea; Filed December 9, 1968; Serial Number 782,291; 7 Claims. (Cl. 89–7).

3,602,087; OBTURATOR FOR MACHINE GUN HAVING LATERALLY SLIDING BREECHBLOCK; John H. Scanlon, Jr.; Monroe, Conn.; assignor to the United States of America as represented by the Secretary of the Army; Filed February 6, 1970; Serial Number 9,303; 6 Claims. (Cl. 89–26).

3,602,088; ARMORED TANK VEHICLE WITH ANTI–AIRCRAFT ARMAMENT; Time Spring, Dubendorf, Switzerland; assignor to Contraves AG, Zurich, Switzerland; Filed March 25, 1969; Serial Number 810,143; Claims priority application Switzerland, April 3, 1968; 6 Claims. (Cl. 89–36 K).

3,602,089; AMMUNITION LOADING DEVICE; Lucien Beaufrere, Bourges, France; assingor to Etat Francais; Filed December 19, 1969; Serial Number 886,701; Claims priority; application France, December 19, 1968; 179,260; 10 Claims. (Cl. 89–47).

September 7, 1971

3,603,015; EJECTED SHELL RETAINER; Kenneth W. Jensen, 9309 Louis, Detroit, Michigan; Filed April 4, 1969; Serial Number 813,585; 10 Claims. (Cl. 42–1).

3,603,020; MAGAZINE ASSEMBLY WITH EXPENDABLE CARTRIDGE CONTAINER UNIT; Harold H. Wiese, Davenport, Iowa; assignor to the United States of America as represented by the Secretary of the Army; Filed March 27, 1970; Serial Number 23,142; 7 Claims. (Cl. 42–50).

3,603,201; FIRING MECHANISM FOR HIGH RATE OF FIRE REVOLVING BATTERY GUN; Anthony J. Aloi, Burlington, Vt.; assignor to General Electric Company; Filed November 24, 1969; Serial Number 879,277; 7 Claims. (Cl. 89–12)

3,603,202; MUZZLE BRAKE; Edward L. Moragne, 4723 Nenana, Houston, Texas; Filed June 16, 1969; Serial Number 833,343; 6 Claims. (Cl. 89–14 C).

September 14, 1971

3,604,136; SHOTGUN COUNTERBALANCE; Jesse B. Edwards, 269 Herbert St., Madison, Ill.; Filed September 5, 1968; Serial Number 758,654; 1 Claim. (Cl. 42–1 R).

3,604,137; SIGHTING SYSTEM FOR A FIREARM-CARRIED GRENADE LAUNCHER; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 17, 1967; Serial Number 834,117; 5 Claims. (Cl. 42–1 S).

3,604,138; FIREARM RECOIL PAD SHOCK ABSORBER; Jack W. Wilson, 8211 E. Garfield, Phoenix, Arizona; Filed September 4, 1969; Serial Number 855,171; 7 Claims. (Cl. 42–74).

3,604,142; FOUR-STACK CARTRIDGE MAGAZINE; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army; Filed June 30, 1960; Serial Number 837,452; 7 Claims. (Cl. 42–50).

3,604,308; MEANS FOR RELEASABLY LATCHING A RECOILING MASS AGAINST COUNTERRECOIL MOVEMENT; Robert J. Schulz, Davenport, Iowa; Jimmy H. Williams, Bettendorf, Iowa, and Robert J. Seamands, Moline, Ill.; assignors to the United States of America as represented by the Secretary of the Army; Filed July 11, 1969; Serial Number 841,013; 17 Claims. (Cl. 89–42 B).

September 20, 1971

3,605,311; REMOVABLE FIREARM LOCK INSERTABLE IN THE FIREARM EJECTION PORT; Robert Hermann, P.O. Box 114, Strongburse, Ill, 61480; Filed January 22, 1969; Serial Number 793,006; 1 Claim. (Cl. 42–1 N).

3,605,312; LEVER ACTUATED SAFETY MECHANISM FOR A FIREARM; Robert E. Domian, Tolland, Conn.; assignor to Colt's Inc., Hartford, Conn.; Filed July 15, 1969; Serial Number 841,836; 11 Claims. (Cl. 42–70 E).

3,605,313; CHOKE MEANS; Jeremiah J. Kranz, 3620 Jefferson Street, Rapid City, S. Dakota, 57701; Filed February 6, 1969; Serial Number 797,149; 4 Claims. (Cl. 42–79).

3,608,223; FIRING PIN AND EXTRACTOR MECHANISM FOR FIREARMS; Ralf E. Dieckmann, Stratford, Conn.; assignor to Bridgeport Firearms Company, Monroe, Conn.; Filed November 8, 1968; Serial Number 774,325; 6 Claims. (Cl. 42–25 R).

September 28, 1971

3,608,224; SEAR–TRIGGER SAFETY MECHANISM FOR FIREARMS; Carl B. Hildebrandt, Springfield, Mass.; assignor to Emhart Corporation, Bloomfield, Conn.; Filed December 19, 1969; Serial Number 886,716; 6 Claims. (Cl. 42–70 C).

3,608,225; PORTABLE GUN SUPPORT Benjamin Manuel, 112 Arch Street, Pittsburgh, Pa., 15212; Filed February 12, 1970; Serial Number 13,877; 6 Claims. (Cl. 42–94).

3,608,422; FRONT LOADING FIRING APPARATUS; Reginald Bretnor, Berkeley, Calif.; (P.O. Box 748, Jacksonville, Oregon, 97530); Filed December 16, 1968; Serial Number 783,902; 11 Claims. (Cl. 89–1 F).

3,608,424; FEEDING MECHANISM OF AN AUTOMATIC CANNON FOR FIRING CASELESS AMMUNITION; Harold H. Wiese, Davenport, Iowa; assignor to the United States of America as represented by the Secretary of the Army; Filed October 8, 1969; Serial Number 864,849; 11 Claims. (Cl. 89–13 R).

3,608,425; HIGH SPEED FIRING MECHANISM; Gilbert S. Jackson, West Hyattsville, Md.; assignor to Jesse D. Stteele, Chevy Chase, Violet Ann Ash, Rockville, and Nicholas J. Aquilino, Crofton, Md.; fractional part interest to each; Filed December 31, 1968; Serial Number 788,223; 5 Claims. (Cl. 89–27).

3,608,426; DOWN–FIRE ARMAMENT POD FOR HELICOPTERS; Lester L. Jackson, Jr.; Towson, Md.; assignor to Martin Marietta Corporation, New York, N.Y.; Filed February 14, 1969; Serial Number 799,294; 3 Claims. (Cl. 89–37.56).

3,608,427; BOLT LOCKING SYSTEM; Richard H. Colby, Hamden, Mass.; assignor to General Electric Company; Filed April 7, 1969; Serial Number 814,083; 4 Claims. (Cl. 89–176).

October 5, 1971

3,609,900; RIMMED SHELL RESTRAINT; William Bernocco, Jr., 355 Parker, Dearborn, Michigan, 48124; Filed August 11, 1969; Serial Number 856,241; 7 Claims. (Cl. 42–1 R).

3,609,902; HANDGUN SUPPORT; Richard J. Casull, 3270 Del Mar Drive, Salt Lake City, Utah, 84109; Filed March 17, 1970; Serial Number 20,373; 10 Claims. (Cl. 42–72).

3,609,903; RECOIL PAD WITH INTEGRAL ATTACHING BOSSES AND METHOD OF MOUNTING; Frank A. Pachmayr, Los Angeles, and Jack R. Farrar, Whittier, Calif.; assignors to Pachmayr Gun Works, Inc.; Los Angeles, Calif.; Filed March 13, 1970; Serial Number 19,252; 17 Claims. (Cl. 42–74).

3,609,904; EXTRACTABLE PLASTIC CARTRIDGE; John J. Scanlon, Monroe, Conn.; assignor to Remington Arms Company, Inc.; Bridgeport, Conn.; Filed May 7, 1969; Serial Number 822,498; 2 Claims. (Cl. 42–76).

3,610,091; BALLISTIC DEVICE COMPRISING A PROJECTILE AND ITS LAUNCHER; Robert Bornand, Meyrin, Geneva, Switzerland, assignor to Transurvey Holding Company, Inc.; Filed February 10, 1969; Serial Number 798,058; Claims priority, application Switzerland, February 8, 1968; 8 Claims. (Cl. 89–1 F).

October 12, 1971

3,611,606; TELESCOPIC SIGHT MOUNT FOR RIFLES; Harry H. Sefried, New Haven, Conn.; and Leroy J. Sullivan, Huntington Beach, Calif.; assignors to Sturm Ruger & Co., Inc.; Southport, Conn.; Filed May 7, 1969; Serial Number 822,630; 4 Claims. (Cl. 42–1 S).

3,611,607; FIREARM CONVERSION SYSTEM; Thomas Donnell, 17 Godier Drive, East, St. Louis, Ill., 62203; Filed August 6, 1969; Serial Number 847,890; 19 Claims. (Cl. 42–1).

3,611,608; GUN HAVING TWO SHELL LATCHES WITH A PLURALITY OF CAM FOLLOWERS; Theophilus K. Seiberling, 39 Maplewood Ave., Akron, Ohio, 44313; Continuation in part of abandoned application Serial Number 736,101; June 11, 1968. This application December 24, 1968; Serial Number 788,991; 27 Claims. (Cl. 42–17 R).

3,611,611; BARREL TO RECEIVER CONNECTION FOR FIREARMS HAVING INTERCHANGEABLE BARRELS; James L. Quinney, Jackson, Wyoming; assignor to Idaho Bank of Commerce, Rexburg, Idaho; Filed December 15, 1969; Serial Number 885,382; 5 Claims. (Cl. 42–75 B).

3,611,612; FIREARM FOR FIRING CASELESS AMMUNITION; Michael W. York, 1200 S. Arlington Ridge Road 507; Arlington, Va., 22202; Filed July 15, 1968; Serial Number 744,765; 10 Claims. (Cl. 42–76).

3,611,866; BOLT ASSEMBLY; Charles C. Jacolucci, Richmond, and Gordon H. Woodford, Essex Center, both of Vermont; assignors to General Electric Company; Filed October 22, 1969; Serial Number 868,379; 5 Claims. (Cl. 89–12).

3,611,867; EMERGENCY WEAPON FOR FIRING HIGH VELOCITY GRENADE ROUNDS; Stanley D. Silsby, Granby, Mass.; assignor to the United States of America as represented by the Secretary of the Army. Continuation in part of application Serial Number 776,953; November 19, 1968, now abandoned. This application November 3, 1969; Serial Number 873,426; 5 Claims. (Cl. 89–14 R).

3,611,868; AUTOMATIC FIREARM WITH TWO SELECTIVELY EMPLOYABLE CARTRIDGE FEED DEVICES; Gerhard Hupp, Oberndorf, Neckar, Germany; assignor to Mayser-Werke A.G., Oberndorf/Neckar, Germany; Filed May 7, 1969; Serial Number 822,514; Claims priority, application Germany, May 10, 1968; 4 Claims. (Cl. 89–33 SF).

3,611,869; AUTOMATIC FIREARM WITH A CHANGEOVER CARTRIDGE FEED DEVICE; Gerhard Hupp, Oberndorf, Neckar, Germany; assignor to Mauser-Werke A.G., Oberndorf, Germany; Filed May 7, 1969; Serial Number 822,513; Claims priority, application Germany, May 10, 1968; 2 Claims. (Cl. 89–335 F).

3,611,870; CARTRIDGE MAGAZINE CONSTRUCTION; Kerl Ernst Udert, Triesen, and Hans Umbach, Stadein, both of Germany; assignors to Hiki Aktiengesellschaft, Schaan, Liechtenstein; Filed December 26, 1968; Serial Number 787,055; Claims priority, application Germany; March 11, 1968; 9 Claims. (Cl. 89–35).

3,611,871; FIRING MECHANISM FOR HIGH RATE OF FIRE REVOLVING BATTERY GUN; Robert G. Kirkpatrick, Shelburne, and Lincoln L. Sibley, Jr.; South Burlington, both of Vermont; assignors to General Electric Company; Filed March 31, 1970; Serial Number 24,199; 6 Claims. (Cl. 89–127).

3,611,872; LIGHTWEIGHT COMPACT RIFLE; Dale M. Davis, Route 1 Box 238, Freeport, Florida; Filed June 2, 1969; Serial Number 829,413; 2 Claims. (Cl. 89–136).

3,611,873; BLOWBACK FIREARM WITH RETARDED EXTRACTION; Thormon O. Ellison, Box 163; Route 3, Aberdeen, Md.; Filed March 21, 1969; Serial Number 809,348; 2 Claims. (Cl. 89–180).

October 19, 1971

3,613,282; ELECTRICAL IGNITION SHOTGUN FOR FIRING CASELESS AMMUNITION; Marcus Ransay, New Haven, Conn.; assignor to Olin Corporation; Filed September 15, 1969; Serial Number 857,665; 18 Claims. (Cl. 42–84).

3,613,285; REVOLVER CYLINDER PIN AND LOCK THEREFOR; Ralph C. Kennedy, Wapping, Conn.; assginor to Colt's Inc., Hartford, Conn.; Filed January 22, 1970; Serial Number 4,848; 4 Claims. (Cl. 42–59).

3,613,286; REVOLVER WITH DOUBLE ACTION; Klaus Mayer, 9 Arnsberger Strasse, Nehelm-Husten, Germany; Filed April 16, 1969; Serial Number 816,656; 2 Claims. (Cl. 42–65).

3,613,499; SWITCH FOR PROJECTILE ACCELERATING SYSTEM; Frank T. Hubbard, Valcartier, Quebec, and Gaston Demers, Gap Rouge, Quebec, both of Canada, assignors to Her Majesty the Queen in right of Canada as represented by the Minister of National Defence. Filed September 24, 1969; Serial Number 860,677; Claims priority, application Canada, September 25, 1968; 5 Claims. (Cl. 89–8).

3,613,500; COMBINATION PROJECTILE GUIDE AND FIRING CHAMBER SEAL; Francis J. Warin, Oakharbor, Ohio; assignor to TRW Inc., Cleveland, Ohio; Filed February 18, 1969; Serial Number 800,103; 9 Claims. (Cl. 89–26).

October 26, 1971

3,614,907; BLOW-OUT DISC; Nils E. Haglund and Knut G. Knutsson, Eskilstuna, Sweden, assignors to Forenade Fabriksverken, Eskilstuna, Sweden; Continuation in part of application Serial Number 672,573; October 3, 1967. This application March 12, 1969; Serial Number 806,373; Claims priority application Sweden, October 4, 1966; 4 Claims. (Cl. 89–1.7).

3,614,908; REMOVABLE UNITARY ACTION FOR A FIREARM; Gary Wilhelm, Hamden, Conn.; assignor to Stoeger Arms Corporation, South Hackensack Township, Bergen County, N.J.; Filed October 7, 1968; Serial Number 766,380; 5 Claims. (Cl. 89–132).

November 2, 1971

3,616,559; FIREARM TRIGGER LOCK FITTING ON THE TRIGGER GUARD; Edward J. Sobolewski, Moorestown, N.J.; deceased, by Helena Sobolewski, spouse of decedent, 159 Haines Drive, Moorestown, N.H., 08057; Filed September 12, 1968; Serial Number 759,349; 10 Claims. (Cl. 42–1).

3,616,561; MULTIPLE BORE GUN HAVING A ROTATABLE BARREL; Grober E. Hendricks, 2241 Lake Street, Niles Michigan, 49120; Filed March 3, 1969; Serial Number 803,892; 3 Claims. (Cl. 42–1 L)

3,616,562; GUN BARREL RIFLING; Karl Burgsmuller, Haus Hainbert, 335 Kreiensen, Germany; Filed September 2, 1969; Serial Number 854,565; 6 Claims. (Cl. 42–78).

3,616,724; CARTRIDGE FEED MECHANISM FOR A FIREARM; Bernard Maillard, Geneva, Switzerland, assignor to Brevets Aero-Mecaniques S.A., Geneva, Switzerland; Original application April 1, 1968; Serial Number 714,524; now Patent Number 3,447,418; dated June 3, 1969; Divided and this application October 21, 1968, Serial Number 810,861; Claims priority, application Luxembourg, July 31, 1967; 7 Claims. (Cl. 89–33 DF).

3,616,725; REPEATING FIREARM ACTIONS; Armando Piscetta, 4 Via Aicardo, 20141 Milan, Italy; Filed February 25, 1969; Serial Number 801,992; Claims priority, application Italy, February 26, 1968; 7 Claims. (Cl. 89–132).

3,618,244; METHOD FOR FIRING PROJECTILES UNDERWATER; Allan S. Johnson, 845 W. 16th Street, Costa Mesa, Calif., 92627; Continuation in part of application Serial Number 700,816; January 26, 1968. This application February 10, 1969; Serial Number 798,061; 7 Claims. (Cl. 42–1 L).

November 9, 1971

3,618,245; DEVICE FOR BALANCING GUNS; Gene M. Pruonto, 124 E. 1st Ave., Altoona, Pa., 16602; Filed March 3, 1969; Serial Number 803,566; 7 Claims. (Cl. 42–1 R).

3,618,246; FIRING CHAMBER FOR CASELESS CARTRIDGE; William B. Woodring, Stony Creek, Conn.; assignor to Olin Corporation; Original application May 7, 1968; Serial Number 727,164; Divided and this application February 4, 1970; Serial Number 8,637; 1 Claim. (Cl. 42–16).

3,618,247; "SHORT THUMBING" TWO-STEP ABUTMENT FOR FEED LATCHES; Adolph L. Nelson, Detroit, Michigan, assignor to Remington Arms Company, Inc., Bridgeport, Conn.; Filed September 4, 1969; Serial Number 855,317; 3 Claims. (Cl. 42–17 R).

3,618,248; BUTTSTOCK ASSEMBLY WITH A LATCHABLE DOOR FOR A COMPARTMENT FORMED THEREIN; Henry A. Into, Rocky Hill, Conn., and John K. Jorczak, Springfield, Mass.; assignors to Colt's Inc., Hartford, Conn.; Filed June 13, 1969; Serial Number 833,000; 8 Claims. (Cl. 42–71 R).

3,618,249; PIVOTALLY MOUNTED STOCK FOR FIREARMS; Andrew J. Grandy, North Hills, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed August 1, 1969; Serial Number 846,769; 2 Claims. (Cl. 42–73).

3,618,250; LAUNCHING ARRANGEMENT FOR SUB-CALIBER PROJECTILES; Andrew J. Grandy, North Hills, Pa.; assignor to the United States of America as represented by the Secretary of the Army; Filed August 15, 1969; Serial Number 850,462; 2 Claims. (Cl. 42–77).

3,618,453; OPEN BREECH HIGH RATE AUTOMATIC ROCKET LAUNCHER; Corbet M. Cornelison, Huntsville, Alabama; assignor to the United States of America as represented by the Secretary of the Army; Filed November 3, 1969; Serial Number 873,418; 7 Claims. (Cl. 89–1.804).

3,618,454; TWO-DIRECTION AMMUNITION TRANSFER MECHANISM; James R. Christenson, Creve Coeur, Mo.; assignor to Emerson Electric Company, St. Louis, Mo.; Filed September 30, 1969; Serial Number 862,377; 8 Claims. (Cl. 89–33 BB).

3,618,455; MANUAL OPEN– AND CLOSED–BOLT WEAPON FIRE CONTROL WITH AUTOMATIC HEAT RESPONSIVE OVERRIDE; Roy D. Plumer, Santa Barbara, and Harold Shrout, Goleta, Calif.; assignors to General Motors Corporation, Detroit, Michigan; Filed July 25, 1969; Serial Number 844,926; 3 Claims; (Cl. 89–132).

3,618,456; FIRING ZONE LIMITING APPARATUS; Gunter Mindel, Dusseldorf, Germany; assignor to Rheinmetall G.m.b.H., Dusseldorf, Germany; Filed September 2, 1969; Serial Number 854,545; Claims priority, application Germany, September 12, 1968; 7 Claims. (Cl. 89–134).

3,618,457; ROTARY AND SLIDING FIREARM BOLT WITH EXTERNAL CAM; Arthur Miller, 1602 Myrtlewood, Costa Mesa, Calif., 92626; Filed November 25, 1969; Serial Number 879,848; 17 Claims. (Cl. 89–185).

3,618,458; SHELL RETRIEVER DEVICE FOR SHOTGUNS; Gene M. Pruonto, 124 E. 1st Ave., and Robert G. Cummings, 233 E. Crawford Ave., both of Altoona, Pa., 16602; Filed July 15, 1969; Serial Number 841,720; 9 Claims. (Cl. 89–33 SF).

November 10, 1971

3,619,924; SELF-OBTURATING, GAS–OPERATED LAUNCHER; T. O. Paine, Administrator of the National Aeronautics and Space Administration, with respect to an invention of Otto K. Heiney, Temple City, Calif.; Filed September 17, 1969; Serial Number 858,695; 1 Claim; (Cl. 42–1 F).

3,619,925; ADJUSTABLE SKEET WEIGHT FOR FIREARMS; James S. Martin, Wayne E. Leek, and Perry J. Pierce, Jr.; Mohawk, and Thomas G. Bauman, Herkiner, N.Y.; and Earl G. Larson, Fairfield, Conn.; assignors to Remington Arms Company, Inc., Bridgeport, Conn.; Filed November 4, 1969; Serial Number 873,987; 8 Claims. (Cl. 42–1 R).

3,619,926; BOLT ACTUATED EJECTION PORT COVER; James M. Alday, Williamson, N.Y.; assignor to Remington Arms Company, Inc., Bridgeport, Conn.; Filed April 6, 1970; Serial Number 25,815; 7 Claims. (Cl. 42–16 R).

3,619,927; MANUALLY–CONTROLLED FIRING MEANS; Jean Robinet, Toulouse, France; assignor to Etablissement Ruggieri, Paris, France, Filed June 30, 1969; Serial Number 837,449; Claims priority, application France, July 2, 1968; 12 Claims. (Cl. 42–1 R).

3,619,928; FIREARM EJECTOR SYSTEM CAPABLE OF EJECTING SHELLS OF DIFFERENT LENGTHS; James S. Martin, Mohawk, and Charles H. Morse, Herkimer, N.Y.; assignors to Remington Arms Company, Inc., Bridgeport, Conn.; Filed October 29, 1969; Serial Number 872,081; 7 Claims. (Cl. 42–25 R).

3,619,929; MAGAZINE WITH ANTI-DOUBLE-FEED INDENTATIONS IN THE SIDE WALLS; Robert D. Fremont, Farmington, Conn.; assignor to Colt's Inc., Hartford, Conn.; Filed March 13, 1969; Serial Number 806,806; 3 Claims. (Cl. 42–50).

3,619,930; FIRING MECHANISM WITH A PIVOTED FINGER PIECE MOUNTED ON A PIVOTED TRIGGER LINK; Paul Beerman, Kreis Iserlohn, and Willi Grosse-Benne, Menden, Germany, assignors to Richard Rinker, Menden, Sauerland, Germany; Filed July 8, 1969; Serial Number 839,909; Claims priority, application Germany, July 8, 1968; 7 Claims. (Cl. 42–69 R).

3,620,121; RADIAL ACTUATOR AND RELEASE MECHANISM; Charles R. Olsen, 2020 Cypress St., Philadelphia, Pa., 19103; Filed April 15, 1969; Serial Number 816,272; 5 Claims. (Cl. 89–1).

November 16, 1971

3,620,124; FIRING MECHANISM FOR REVERSIBLE AUTOMATIC CANNON; Harold H. Wiese, Davenport, Iowa; assignor to the United States of America as represented by the Secretary of the Army; Filed January 12, 1970; Serial Number 2,305; 7 Claims. (Cl. 89–13 R).

3,620,125; FIXED-BARREL AUTOMATIC PISTOL HAVING A STOPPING DEVICE FOR THE CARRIAGE; Pier Carlo Beretta, Gardone Val Trompia, Italy; assignor to P. Beretta-Armi-Roma S.p.A., Rome, Italy; Filed April 21, 1970; Serial Number 30,383; 4 Claims. (Cl. 89–196).

November 23, 1971

3,621,596; FIREARM WITH FALLING BREECHBLOCK; Carl T. Colliander, Warwick, R.I., and Robert L. Hillberg, Cheshire, Conn.; assignors to Colt's Inc., Hartford, Conn.; Filed September 11, 1969; Serial Number 856,968; 15 Claims. (Cl. 42–23).

3,621,597; ADJUSTABLE FIREARM REST COMPRISING AN IRREGULAR ROTATABLE MEMBER; Gerald E. Price, 9221 Bolsa Avenue, Westminister, Calif., 92683; Filed September 15, 1969; Serial Number 858,054; 7 Claims. (Cl. 42–94).

3,621,598; RIFLE BREECH BOLT LATCH; William B. Ruger, Southport, Conn.; and Leroy J. Sullivan, Huntington Beach, Calif.; assignors to Ruger, Sturm & Co., Inc.; Southport, Conn.; Filed July 22, 1969; Serial Number 843,387; 6 Claims. (Cl. 42–16 F).

November 30, 1971

3,623,256; AMMUNITION MAGAZINE HOLDER; Lewis D. Shiplee III, 818 Concord Road, Tallahassee, Fla., 32303; Filed April 3, 1970; Serial Number 25,350; 7 Claims. (Cl. 42–50).

3,623,257; RIFLE HAND GRIP DEVICE; Lonnie J. Ray, Rte. 2, Piney, Flats, Tenn., 37686; Filed June 12, 1919, Serial Number 832,688; 9 Claims. (Cl. 42–71).

December 7, 1971

3,624,945; UNIVERSAL SELF–CONFORMING TRIGGER LOCK FOR FIREARMS; Daniel J. Foote, Wauwatosa, Wis.; assignor to Master Lock Company, Inc.; Filed April 13, 1970; Serial Number 27,634; 6 Claims. (Cl. 42–1 Y).

3,624,947; HAMMER SAFETY FOR FIREARMS; George H. Worall, Sr., Los Angeles, Calif.; assignor to Salford Imports, Inc., Culver City, Calif.; Filed June 25, 1969; Serial Number 836,370; 18 Claims. (Cl. 42–66).

December 14, 1971

3,625,107; FEED MECHANISM FOR AN OPEN BREECH HIGH RATE AUTOMATIC ROCKET LAUNCHER; Arthur A. Smith and Corbet M. Cornelison, Huntsville, Ala., assignors to the United States of America as represented by the Secretary of the Army; Filed November 3, 1969; Serial Number 873,295; 2 Claims. (Cl. 89–1.8).

3,626,620; GUNS HAVING A FLOATING FIRING CHAMBER; John Gonsalves Rocha, Westfield, Mass.; assignor to Maremont Corporation, Chicago, Ill.; Filed January 15, 1969; Serial Number 791,308; 7 Claims. (Cl. 42–15).

3,626,621; PERCUSSION FIRING MECHANISM FOR A BREECH LOADED GUN; Chiyoki Ido, Kochi, Japan, assignor to Kabushiki Kaisha Miroku Seisakusho, Kochi, Kochi Prefecture, Japan; Filed February 25, 1969; Serial Number 802,123; Claims priority; application Japan, March 5, 1968; 2 Claims. (Cl. 42–41).

3,626,622; SAFETY DEVICE FOR REVOLVERS; Aldo Uberti, Piazza Garibaldi 3, Gardone Val Trompia, Italy; Filed September 10, 1969; Serial Number 856,548; Claims priority; application Italy, July 16, 1969; 3 Claims. (Cl. 42–66).

3,626,623; HAMMER MOUNTED SAFETY DEVICE FOR REVOLVERS; Aldo Uberti, Piazza Garibaldi 3, Gardone Val Trompia, Italy; Filed August 8, 1969; Serial Number 848,583; Claims priority application Italy, June 25, 1969; 3 Claims. (Cl. 42–66).

3,626,624; ELECTRO–MECHANICAL FREE PISTOL; Franklin C. Green, 6304 Locker Land, San Antonio, Texas, 78238; Filed March 10, 1969; Serial Number 805,470; 11 Claims. (Cl. 42–84).

3,626,805; MODIFICATION ASSEMBLY FOR CHANGING SEMIAUTOMATIC FIREARMS SELECTIVELY INTO FULLY AUTOMATIC FIREARMS; Lewis D. Shiplee, III, 818 Concord Road, Tallahassee, Florida; Filed October 15, 1969; Serial Number 866,989; 9 Claims. (Cl. 89–128).

3,628,272; CYLINDRICAL BREECH WITH SLEEVED OBTURATOR; Jules E. Van Langenhoven, La Hulpe, Brussels, Belgium, assignor to Engineering Developments Limited, Fribourg, Switzerland; Filed July 24, 1969; Serial No. 844,458; 6 Claims (U.S. Cl. 42–39.5).

3,628,273; CARTRIDGE TUBE LOADER; Andrew Lach, 14303 Sylvan Street, Van Nuys, California; Filed June 5, 1970; Serial No. 43,677; 12 Claims (U.S. Cl. 42–87).

December 21, 1971

3,628,277; ROUND EXTRACTOR FOR CASELESS FIREARM; Roy D. Plumer, Santa Barbara, and Harold Shrout, Goleta, both of Calif., assignors to General Motors Corporation, Detroit, Mich.; Filed July 18, 1969; Serial No. 843,097; 4 Claims (U.S. Cl. 42–25).

3,628,278; REVOLVER CYLINDER CRANE LATCH MECHANISM; William B. Ruger, Southport, Conn., assignor to Sturm, Ruger & Co., Inc., Southport, Conn.; Filed February 11, 1970; Serial No. 10,525; 8 Claims (U.S. Cl. 42–62).

3,628,415; MORTAR; Stuart H. McElroy, Box 278, Dahlgren, Va.; Filed Jan. 27, 1970; Serial No. 10,108; 8 Claims (U.S. Cl. 89–1 F).

3,630,118; TWO-STEP AMMUNITION FEEDER; Eugene M. Stoner, 2292 No. Carriage Lane, Port Clinton, Ohio; Filed September 5, 1969; Serial No. 855,492; 9 Claims (U.S. Cl. 89–33C)

3,630,119; GAS-OPERATED TOGGLE ACTION WEAPON; Walter E. Perrine, 1822 North 24th Street, Phoenix, Arizona; Filed December 4, 1969; Serial No. 882,009; 7 Claims (U.S. Cl. 89–189).

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